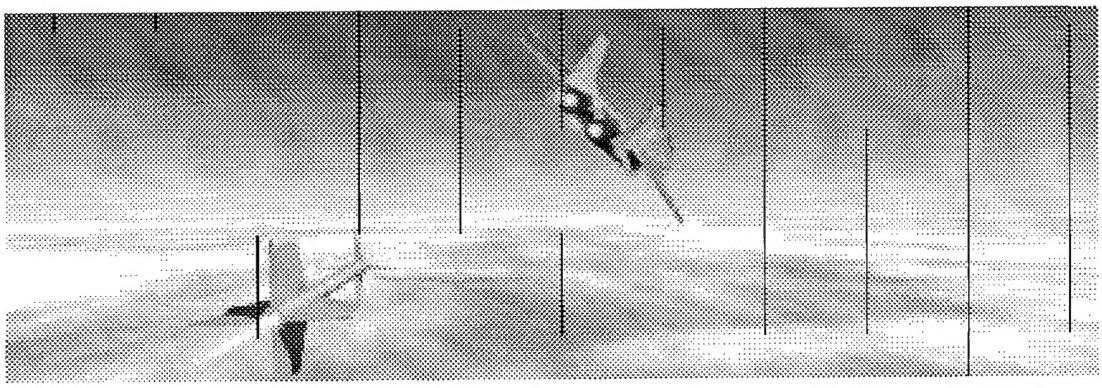
To Kill a Stalking Bird

Fodder for Your Professional Reading on Air and Space Superiority

DR. DAVID R. METS*



SINCE THE EARLIEST DAYS of aviation, the most important and probably least controversial of the Air Force missions has been air superiority—and now air and space superiority.[1] In fact, most of the initial impetus for the development of the capability to control the air came from the ground generals in World War I. Air reconnaissance and artillery spotting had become so important to ground battle that the generals wanted to prevent enemy interference with their own reconnaissance and spotting and deny those functions to the adversary. By the middle of the Great War, that led to the genesis of air units specialized to command the air.[2] It is clear enough that although air power had not been decisive in that war, soldiers and airmen alike predicted that in future campaigns, it would be necessary to control the third dimension before other goals could be achieved there—on the ground or at sea.

Hopefully, the reader and Harper Lee[3] will indulge my play on words in the title. My excuse is that most of the time, American air combat has taken place not in defensive roles but on the offensive—to protect our attacking air-to-ground birds that themselves were being stalked by Fokkers, Messerschmitts, Mitsubishis, and MiGs. The purpose of this article, then, is to give the reader a survey of the way that our theory, doctrine, and technology for air and space superiority have evolved. Hopefully, that will be a stimulant for additional professional reading on the subject. To facilitate that, I shall include a starter list of readings I recommend to midlevel professional air warriors/scholars for the enhancement of their grasp of the primary Air Force core competency. Finally, the article reviews

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A Shoestring Primer on the Evolution of Air and Space Superiority Theory and Doctrine

World War I, 1914–18: There had been stray thoughts about the need to command the air even before the outbreak, but as of 1914 air units had not been specialized according to function. Air combat did begin even in 1914, but it was not very effective then. However, technological gains in engines and armament made it more important to specialize squadrons intended to command the air—both engine power and the development of synchronizers were important here. Air superiority swung from one side to the other because of advances in air combat, and there was even an early example of what we would call offensive counterair (OCA)* today when the British had to withdraw several fighter outfits from the front to respond to the German air attacks on London—which yielded an advantage to the Germans over the front.

Interwar Period, 1919–39: In general, most air men emerged from the war with the no tion that the key to air su pe ri or ity was air com bat be tween fight ers. In the United States, for example, the 1st Pur suit Group was thought of as the elite unit of the Air Serv ice and early Air Corps until the late 1920s. However, the march of technology and the arguments of Giulio Douhet made the notion of air superiority through attacks on enemy airpower on the ground ever more attractive. Billy Mitchell thought that air superiority might be achieved through some mix ture of air com bat and ground at tack, but Douhet thought that the lat ter would be by far the more important element. As the 1930s wore on, though, Air Corps thinkers were increasingly won over to an OCA approach.

World War II, 1939–42: Radar had been little anticipated before World War II, yet it did much to weaken the potential for OCA and strengthen the air defense. The Luftwaffe achieved some marvels by opening its attack on Poland and France with assaults on enemy air power on the ground—and then again against the Red Air Force in 1941. But in the in terim in 1940, in large part be cause of ra dar, the at tack on the Royal Air Force (RAF) and its in fra - struc ture on the ground failed. The US Eighth Air Force made a ma jor ef fort to wreck the German air force and its supporting aircraft industry on the ground, but the results were disappoint ing to say the least. Though the short age of oil (in part due to US air at tacks on syn thetic plants) weak ened the Luft waffe, Gen Carl Spaatz and many oth ers emerged with the con clusion that the air bat tle be tween the es corts and the stalk ing Focke-Wulfs and Mess erschmitts had been es sen tial to the win ning of air su pe ri or ity. Up to that point, prac ti cally all of the air-to-air kills had been done by guns (and unguided rockets). Although most other countries were moving to cannons toward the end of the war, the United States stuck with the .50-caliber Brownings.

Dawn of the Cold War, 1945–65: A com bi na tion of things made the Air Force in creas ingly specialized in long-range nuclear attack during the late 1940s while the rest of its functions were sadly underfunded. Nuclear weapons, jets, and long-range missiles were coming on strong, and the thought was that any war would be short and to tal. How ever, we got into Ko-

*OCA refers to offensive operations intended to destroy enemy airpower on its bases or in its factories, or through air battles over its own territory. Defensive counterair refers to winning air superiority through air defense over one's homeland as with the Royal Air Force in the Battle of Britain.

rea, and because the unanticipated political limits prevented a true OCA attack across the Yalu River, most of the job was done with air-to-air combat in the extreme northern reaches of the peninsula. It was the first great campaign among jets, but the weapons were still guns—.50-caliber Brownings on the US part and cannons on the Communist side. The technical virtues of the MiG-15 were a nasty surprise to us, but we decided that crew experience and training had been decisive. After the Korean War, the United States returned to its emphasis on strategic nuclear attack although it was still introducing new jet fighters at short intervals. By then, the United States was going over to cannons, the 20 mm appearing first in the late models of the F-86 and the now-standard M-61 of the same caliber first appearing in 1958 in the F-104 and F-105. By the end of the 1950s, the United States led the way to the air-to-air missile (AAM), the first kill being made by a Sidewinder off a Chinese Nationalist F-86 in 1958. Toward the end of the period, a portent of things to come was the downing of a US U-2 over the USSR in 1960 by a surface-to-air missile (SAM). The greater part of Eighth Air Force losses in the last year of World War II had been to antiaircraft artillery (AAA), but the surface element of the air superiority battle nevertheless received little thought before Vietnam.

High Noon of the Cold War, 1965–82: There had been substantial enthusiasm for AAMs before Vietnam, but their kill ratios turned out to be disappointing, and it was deemed necessary to go back to a gun installation in fighters where it had been omitted. The ground defenses in North Vietnam turned out to be more formidable than had been foreseen, and that stimulated the building of a suppression of enemy air defenses (SEAD) capability that had not been much anticipated. There was a synergy between the North Vietnamese fighters, SAMs, and AAA that had been underestimated. Most of the US fighters had not been optimized for the air battle, and that was costly. All the same, the greater part of the kills were done by infrared and radar missiles, and in the Arab-Israeli wars, the trend was duplicated. The Israelis achieved a classic victory with an OCA attack in 1967, but the air battle was much more important in 1973, and there, too, the missile kills were becoming a greater part of the whole. By 1982 all of the British kills in the Falklands War were done with missiles, and almost all of the kills in the Israeli operation in the Bekaa Valley that same year were by the same method.

Twilight and Sunset of the Cold War, 1982–Present: The Air Force reacted to the frustrations of Vietnam in part by designing three new fighters: one optimized for air combat (F-15), one for close air support (CAS) (the A-10), and one swing-role bird (F-16) for both ground attack and air combat. Later, it moved to create a follow-on to the F-15C with the F-22, originally optimized for air-to-air combat. Unlike the F-4C, all these aircraft except the A-10 came equipped with the M-61 20 mm cannon plus missiles, although most of the F-16s had only infrared Sidewinders. The F-15 came with both Sidewinder and semiactive radar missiles (AIM-7, Sparrows), and later when the AIM-120 active radar missile proved successful, both aircraft were retrofitted with it. Again in the Gulf War, almost all of the kills were by missiles, and the United States seems to have suffered only one loss to the stalking birds—a Navy airplane that may have fallen to a MiG missile. All the rest of the losses were to SAMs and AAA. By then, though, stealth had entered the equation to weaken the SAM threat, and SEAD also helped greatly. At the end of the day, many airmen hoped that the US dominance of the Gulf War air battle might be continued by the coming of the F-22 with all the advantages discussed above plus stealth, supercruise (sustained supersonic speed without afterburner), and an ever increasing information edge.

an important new work on the subject, Col Marshall L. Michel's Clashes: Air Combat over North Vietnam, 1965-1972.[4]

The Current Conceptual Framework: Air and Space Superiority

The current, official vision of the way in which superiority in the third dimension—the air and space regime—should be achieved and maintained is contained in Air Force Doctrine Document (AFDD) 1, Air Force Basic Doctrine, of September 1997. It is signed by the current USAF chief of staff, Gen Michael E. Ryan.[5] Doctrine is said to emerge from history and from speculative thought, and there is much in the current concept that has come down to us from the earlier manuals and experience in war. The new document asserts that the offensive is often the more effective way to foster air superiority. That has been a strongly held notion among airmen from the very beginning.[6] Thus, the function is divided up into OCA and defensive counterair (DCA), with the airman's preference usually being the former. For a time, the Air Force was proposing that the conceptualization of the function include yet another mission area—SEAD—but it was unable to persuade our allies to go along with that to make it a part of NATO doctrine.[7] So in that context, SEAD has remained a part of OCA, and that practice is now also carried into the new Air Force basic doctrine manual.

One of the ideas inherited from the past has to do with air superiority as an objective. Douhet thought that the mere achievement of command of the air would make the enemy case so hopeless that it might even be enough to impose one's will on him without the need to punish his civilian population and wreck his economy.[8] But it did not turn out that way in World War II, and by the time the US Army Air Forces (USAAF) set to writing its scheme to defeat Germany in the summer of 1941 (Air War Plans Division, Plan 1 [AWPD-1]), it was clear to the authors that air superiority was instead a means to an end. It was not a final objective but an intermediate one that would take priority in point of time to enable the achievement of later goals.[9] It is the later concept that is in the current Air Force doctrine manual, asserting that the struggle for air supremacy, or at least air superiority, usually has to be the first call of the air commander. It does recognize, however, that sometimes in desperate ground emergencies, it may be necessary to divert air forces to the support of ground units. It also allows that sometimes the battle for air superiority may be conducted simultaneously with other operations—parallel attack, to use the modern vernacular.[10] As noted, it does distinguish between air supremacy and air superiority and laments that sometimes the achievement of the former may simply be too expensive. It also warns against premature relaxation of the pressure because of the possibly huge penalties of even a temporary revival of enemy ability to contest the command of the air. Finally, in its discussion of the "core competencies," the new manual unifies the effort to achieve space superiority with the battle for air superiority. In a later chapter, when discussing the functions of airpower and space power, it creates separate categories for counterair and counterspace.[11]

In its discussion on functions and elsewhere, the 1997 version of basic doctrine continues the traditional Air Force emphasis on the centralization of command—especially for the sake of the battle for control of the air. Both OCA and DCA must be under the command of a single airman in order to implement the idea of centralized control and decentralized execution for the most efficient accomplishment of those functions.[12]

The Genesis of Air Superiority Theory and Doctrine

Central to the very definition of professionalism is the requirement that the members have a specialized expertise and a system of schools to develop it. In America, at first, it was a technical expertise: civil engineering

for the Army and mechanical or steam engineering for the Navy. But after the Civil War, the technical dimensions were reduced, and the education systems focused more on the professional officer as a military rather than technical expert. As with other professions, the history of the development of this expertise was a vital part of the professional's understanding.[13] So, one can argue that anyone who would understand the current conceptual framework for the primary Air Force core competency must know something of its evolution.

It is not at all surprising that the idea that people must control the medium in which they operate should come to the fore in the very earliest days of aviation. At the outbreak of World War I, we were emerging from the heyday of Alfred Thayer Mahan, during which his argument was that if a state gained command of the sea, then all else would follow. Even Douhet was explicit in the notion that the concept should be expanded from the sea to the air.[14]

The machine gun is often given the major credit for the World War I defensive stalemate when it should really be more widely shared with many other factors. Artillery was one. The Civil War round used to fragment into two or three pieces. However, by World War I, artillery projectiles could be made to reliably burst above the surface and to shower thousands of high-velocity fragments on those in the open below. On the defensive, the infantryman was in a trench; on the offensive, he was in the open. Another factor was the presence of prying eyes above, some in balloons but many more in aircraft. It was then the rule that the offensive had to have a numerical advantage of three or four to one to have any chance of overcoming a prepared defensive line. But how was a general to accumulate that kind of mass when aircraft were warning his adversary in plenty of time to undertake countermeasures? So it happened that a cry came up first from the ground commanders that one must have air superiority over the battlefield. Ground generals must have a free ride for their own observation aircraft; enemy generals must be denied a free ride for theirs.[15]

But how could an air force achieve this? Immediately after the guns of August spoke their piece, aviators began casting about for methods of gaining air superiority. Some of the things tried seem pretty bizarre now. The Russians actually achieved an air-to-air kill with a towed grappling hook. The British flew above attacking zeppelins to drop flaming darts onto their hydrogen-filled envelopes. Booby traps were set up in the baskets of captive observation balloons by filling them with explosives. When an attacking fighter rolled in on them, the observer would parachute out of the basket, and the operator on the ground would detonate the charge when the enemy was near the balloon.[16]

But the problem was gradually overcome by a combination of more conservative measures. First, engine power was increased rather rapidly as propulsion was still on the steep part of its development curve. Also, the Lewis gun was adapted to aerial combat, and it was only about half as heavy as the Maxims and Vickers of older design—and it did not need a water jacket. But if one added a second crew member to man the gun, then the weight increase would certainly prevent overtaking enemy aircraft and therefore defeat the purpose. Putting the guns outboard of the propeller arc was tried, but neither they nor their ammunition was yet reliable enough to place them out of the reach of the pilot. Finally, means were found to fix the gun to the aircraft and fire it through the propeller arc without shooting one's self down. Thus, pilots were then able to aim their whole aircraft at the target without trying to fly and manipulate a gun at the same time.[17]

But technology alone was not enough. By the middle of the war, general-purpose aviation units were supplemented by specialized squadrons. On both sides of the line, organizations optimized for air combat were built. On the German side, a defensive policy was generally followed—usually the aviators were instructed to give combat only over their own territories. In the British case, Hugh Trenchard—at the head of the Royal Flying Corps for much of the war—consistently ordered an offensive approach. This led to many combats

over the German lines and considerable losses. The role of the dogfight in all this has been romanticized in the popular literature. The vast majority of kills were done on crews who did not know they were under attack until they were hit—one pass and away was already a good tactic.[18] By midwar, formation flying for the sake of both mass and situational awareness was common practice on both sides.

In general, it is probably fair to say that most aviators carried away the idea that air superiority is the most important mission and that it is best achieved in an air battle. Airdrome attack had been tried but was not all that successful. No one had given much thought to AAA before the war, and it was held in disdain by most of the aviators coming home.[19]

Most airmen and soldiers realized that airpower had not been a decisive factor in the outcome, but most of those were predicting that command of the air would soon become necessary to the success of all other operations on land, at sea, and in the third dimension. In the words of Billy Mitchell himself, "The principal mission of Aeronautics is to destroy the aeronautical force of the enemy, and, after this, to attack his formations, both tactical and strategical, on the ground or on the water. The secondary employment of Aeronautics pertains to their use as an auxiliary to troops on the ground for enhancing their effect against hostile troops."[20]

The Interwar Air Superiority Thought

Mitchell was undoubtedly speaking for the majority of airmen in the early twenties in insisting that air superiority was the first mission and a prerequisite of everything else. Those were austere times, and only three groups were allowed in the Air Service, organized along functional lines. The fighters (then called pursuits) were brought into the 1st Pursuit Group, and clearly that was the elite organization. There was one bomb group, the 2d, and one attack unit, the 3d Attack Group. It was clear enough that Douhet then thought that command of the air in the future would be achieved by massive attacks on enemy air forces and their supporting structures on the ground. But in America, the thought was that a part of the contest would take place in the air. Douhet contended that bomb units might well be all that was required, but Mitchell in the early twenties argued that a balanced force of fighters and bombers as well as ground-attack and observation aircraft would be necessary.[21]

Mitchell was court-martialed and convicted in late 1925, and he resigned from the Army in early 1926. From about that time forward, he moved away from his original balanced-force approach toward Douhet's concentration on strategic attack.[22]

There can be no doubt that the strategic bombing mission was further elaborated and emphasized at the Air Corps Tactical School in the years that followed. However, one must also note that it has often been exaggerated into an obsession in the literature. Neither the attack nor the air superiority mission was ignored, and both were in the curriculum throughout the interwar period.[23]

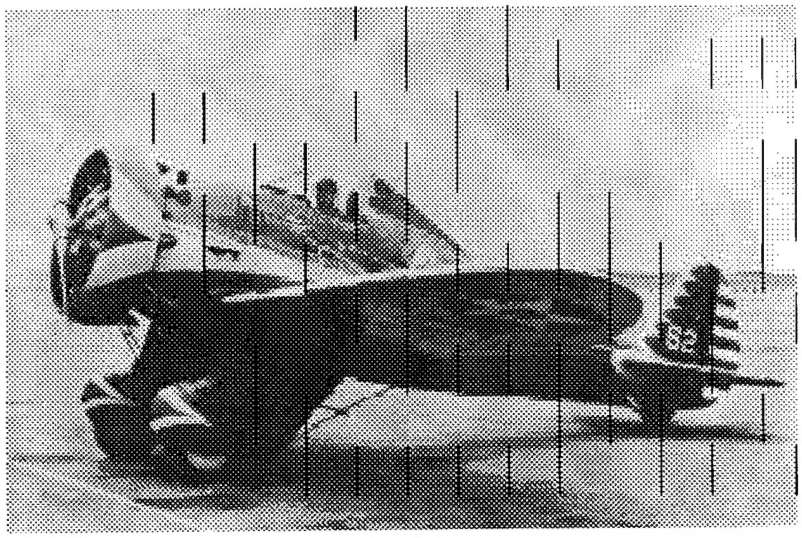
At the school, a heated debate went on in the early and mid-1930s between Claire Chennault and a few other pursuit advocates versus the prevailing majority of bomber enthusiasts.[24] He questioned the "Big Sky" concept and the notion that the bomber would always get through, asserting that an air defense system was practical, given a competent early warning network. The bomber advocates, however, arguing in the absence of any knowledge or anticipation of radar, rejected the Chennault argument. Not only did Chennault agree with the bomber people that the escort fighter was probably an impractical concept, but also he asserted that such use of fighters yields their most precious asset—the initiative.

Too many historians have indulged in the wisdom of hindsight to paint Chennault as a pariah who was right and who was drummed out of the service because of his outspokenness in a correct cause. But arguably Chennault was wrong, and the establishment was right—in the context of the facts then

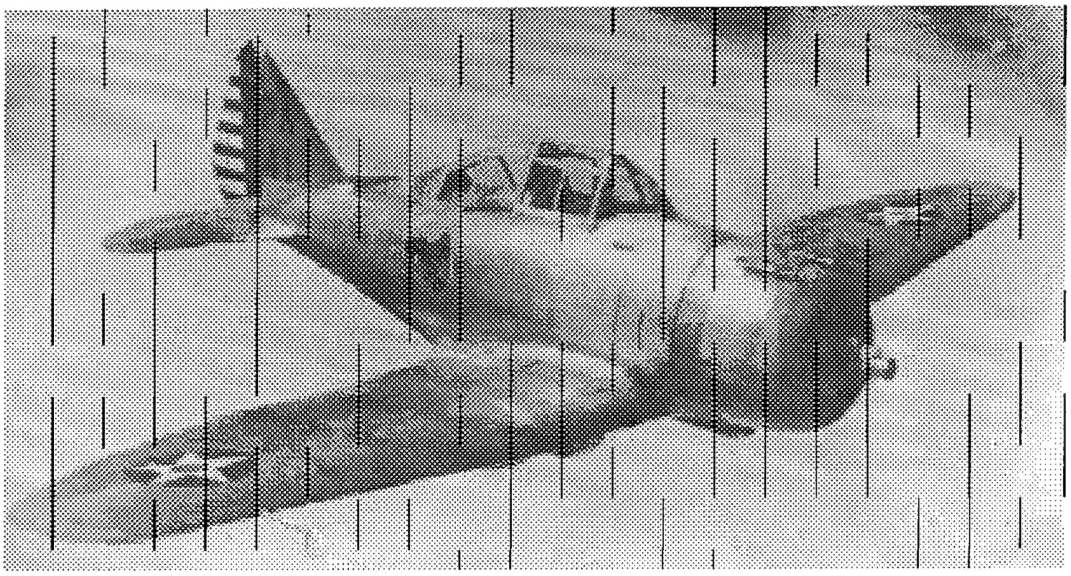
known and assumptions that could then be reasonably made. First, much of the literature was highly colored by the knowledge that five years later, the defense worked in the Battle of Britain. The bomber did not get through. However, radar and an integrated command and control (C^2) system were in place for the Battle of Britain. The disastrous experience of the 33d Pursuit Group at Thelpte in Tunisia two years later in the absence of radar and a competent reporting system showed what was likely to occur.[25] In the mid-1930s, it would have taken a superhuman act of foresight to anticipate the coming of radar in just five short years.[26] Even in Chennault's own theater—China—his argument is weakened by the fact that the Japanese had more important fish to fry than to wreck his forces. In 1944, when the Japanese had been set back on their heels everywhere else, they marched against Chennault's bases in China and were not to be stopped. Finally, the drumming-out part of the story has also been dramatized. As Martha Byrd has shown, Chennault had a lucrative contract in hand in the summer of 1936 from the Chinese Nationalists before he put in his retirement papers.[27]

Further, one can make a plausible case that the Air Corps certainly did not ignore the need for progress in either ground support or pursuit, notwithstanding the emphasis—perhaps even overemphasis—on strategic attack. The doctrinal equivalent of "putting one's money where one's mouth is" may be the kinds of equipment that actually got onto the ramps of attack and pursuit units.

The first monoplane metal bomber—the Martin B-10—got onto the line of the Air Corps in 1932.[28] The first metal monoplane fighter to reach line service in any of the major air forces was the Boeing P-26 Peashooter, arriving in 1933.[29] The first monoplane in the British service, where the threat of bombing attack was much greater than with the United States, was the Hurricane, which got to squadrons in 1936—and did so with fixed-pitch wooden propellers and a partially fabric-covered fuselage. The first unit in the German air force to receive monoplanes traded its biplane He-51s for Messerschmitt 109s in the summer of 1937.[30] The first monoplane fighter in the carrier-deck loads of the Navy was the Brewster Buffalo, which was delivered in 1939. The first Air Corps monoplane fighter with closed cockpit and retracting landing gear was the Seversky P-35, which first flew in 1935 and was ordered in



Boeing P-26 Peashooter



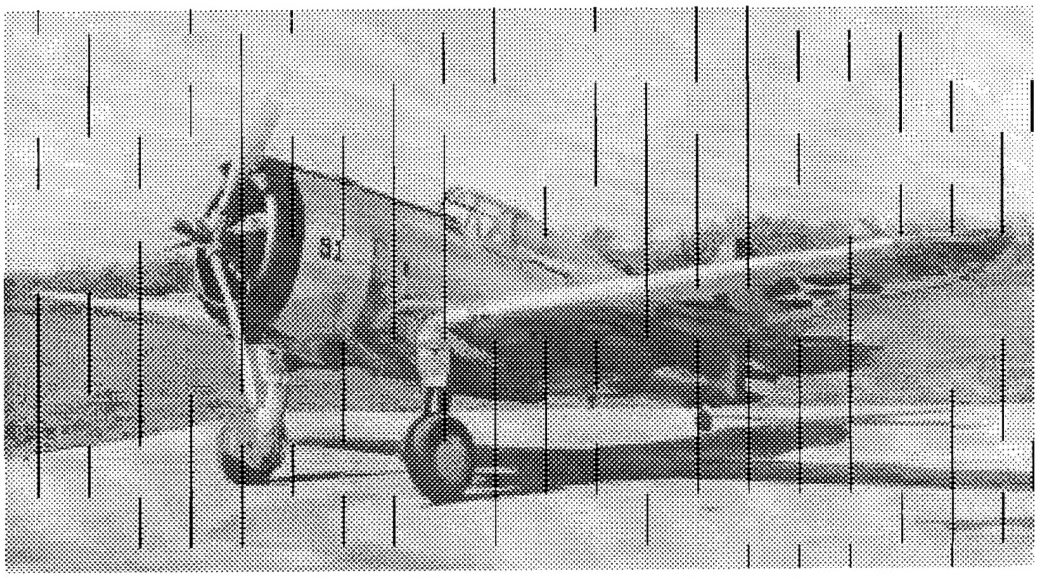
Seversky P-35

quantity in 1937. The Curtiss P-36 was similar, and it too first flew in 1935. Delivery of the production models began early in 1938, and some P-36s were in combat against the Japanese at Pearl Harbor.[31] The first Soviet monoplane fighter with retracting gear and closed cockpit, the Polikarpov I-16, went into squadrons starting in 1934 and outclassed the German and Italian fighters in the first part of the Spanish Civil War—albeit the Russians were still dependent upon Western technology transfer for their engine designs.[32]

The point is that, notwithstanding the lack of a bomber threat against the American homeland, pursuit design was not ignored. It was only in the last months before the war that European fighters began to open a lead over those of the United States—and with good reason because they were much more threatened by possible bombing attacks.

About the time that the B-17 first flew and the P-35 and P-36 were coming into service, a major reorganization of the Army Air Corps took place. In 1935 the General Headquarters Air Force was established at Langley Field, Virginia. It was made up of three wings and resembled the current composite wings much more than the organizations the Air Force has had for most of the time since Pearl Harbor. That is to say, each had a variety of types, including bombers, fighters, and sometimes attack aircraft. Theoretically, each of the wings was similar and qualified for all Air Corps missions. However, the 2d Wing at Langley Field had all of the B-17s, and the 3d Wing at Barksdale Field, Louisiana, was more oriented toward the attack mission. Neither the 1st Wing at March Field nor the other two could be described as having pursuit as a primary function—although all three possessed fighter squadrons.[33]

On the eve of Hitler's attack on Poland, then, there was a heavy emphasis on long-range bombers in the Air Corps even though the equipment to implement that was still scarce. The implication was that a substantial portion of the battle for air superiority would be through the OCA attack on those bases in striking range of the US homeland. The grand strategy was still purely defensive in outlook, and the primary mission was defense. There were indeed some doubts among airmen that the bomber could go it alone. The development of an escort fighter was a low priority—and the hope was that the bombers could be made self-defending. Perhaps that was



Curtiss P-36

only making a virtue out of necessity (or perceived necessity) since the feeling was widespread that any escort with enough tankage to go the route with the bombers would necessarily not be agile enough to contend with short-range interceptors at the far end of the trip.[34] Although Gen Henry Arnold was aware that the Navy was doing research in the area, in the rest of the Air Corps there was not even a glimmering that radar was just around the corner.[35] He was also getting feedback by the summer of 1940 that the Me-110, which had been designed as a long-range escort fighter, was a failure in the Battle of Britain, and the Me-110 itself had to be escorted.[36]

The Impact of World War II

The German attack on Poland in 1939 seemed to be a splendid demonstration that Douhet had been right. The best place to get the stalking birds was in their nests, where they were helpless. That part of the Polish air force that escaped did so by dispersing to outlying bases—where maintenance and supply support were so poor that the sortie rate was driven low enough to be ineffective.[37] Offensive counterair seemed to be the way, and nothing in the experience seemed to contradict the general notion that air superiority came first, followed by interdiction, and—where necessary—direct support of ground forces through CAS.

Battle of Britain

Dunkirk before and Barbarossa after the Battle of Britain seemed to mask some of the doubts that should have arisen from the fight over the British Isles. The Germans started with their standard OCA against the RAF on the ground, but it did not go as well as it had in Poland. Here, they were faced with an integrated air defense system (IADS)—the first in the world. It included radar; a first-class pair of fighters, which were agile and heavily armed; a competent C^2 system; and an elaborate antiaircraft structure under the operational control of the air commander. Further, it also included a good organization of ground observers to supplement the radar and first-class communications. The Luftwaffe persisted in its OCA attack for a while, but when it became frustrated, turned to other objectives (like London), shy of having achieved command of the air. By mid-September 1940,

it had been defeated. The Luftwaffe had made a start against British radar but for several reasons still underestimated its importance.

Many "lessons" came out of the Battle of Britain. Among them was the notion that maybe the bomber would not always get through after all. Defensive counterair can sometimes work. In the words of Gen Carl Spaatz,

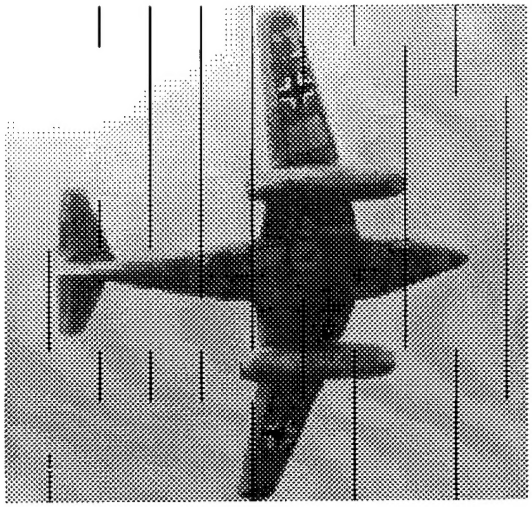
> A well dispersed air force is a most difficult target to destroy on the ground. Bombing attacks against airdromes have resulted in surprisingly little damage against aircraft and combat crews although considerable damage has been done to buildings and major permanent installations. However this damage does not prevent the units from operating effectively. On the other hand the action of fighters against hostile daylight raids has been very effective and in such cases where airplanes are brought down the combat crews are casualties, this in contradistinction to the destruction of planes on the ground. Since the combat crew eventually becomes the neck of the bottle this makes destruction in combat doubly effective. The RAF officers I have spoken to on this subject state that their pre-war conception that the place to destroy an Air Force is at their nests was wrong.[38]

Combined Bomber Offensive

The initial British attempts at bombing the Germans seemed to affirm that DCA had much more potential than had been anticipated, and the RAF went over to night operations to preserve the security of the bomber force. This was done at a considerable cost in target acquisition and bombing accuracy, but it seemed necessary.

When the Americans got into the bombing of Germany, they too learned that the bomber might not be able to get through with acceptable losses. Further, the USAAF made more of an effort to establish air superiority through OCA than did the RAF. The airfields and aircraft factories did prove hard to get, and later the impact of bombing the Luftwaffe's fuel sources was felt only gradually, although from the late spring of 1944 the effect proved increasingly significant. But in the first half of 1944, most of the mayhem worked on the Luftwaffe was done in the air—by US long-range fighter escorts and bomber gunners. Air superiority was achieved by the deadline—the invasion of Normandy. However, the factors leading to that result were complex indeed. Suffice it to say at this point that the USAAF leaders came away with the idea that the bombers could get through with acceptable losses only through a campaign that resembled Mitchell's approach more than Douhet's. There would have to be both an air battle and an attack on the ground echelons of the enemy air force plus its supporting infrastructure. Even in Russia, the effects of the German OCA assault at the outset were only temporary, and at the end of the day the USSR owned the air, very largely through air battle there and over Germany itself. In the words of two of the principals,

> General Carl A. Spaatz: When did you know that the Luftwaffe was losing control of the Air?
>
> Reichsmarschall Hermann Göring: When the American long range fighters were able to escort the bombers as far as Hanover, and it was not long until they got to Berlin. We then knew we must develop the jet planes. Our plan for the early development of the jet was unsuccessful only because of your bombing attacks.[39]



Messerschmitt 262, the jet Göring mentioned

The US Strategic Bombing Survey (USSBS) seemed to agree. It attributed the German loss of command of the air to a combination of attrition of fighters in the air and on the ground and damage to aircraft production, which delayed that program and assured air superiority over Normandy. Command of the air was then sustained by the additional measures of destruction of aircraft fuel sources and, finally, the disruption of the transportation system, which wrecked supply and aircraft repair.[40]

Pacific

In the end, the war against Japan did not do much to change perceptions of the nature of the battle for air superiority. In the Pacific, too, the factors leading to command of the air for the Allies were complex.

The irreplaceable Japanese pilot force suffered severe attrition at the Battle of Midway and during the Solomon Islands campaign. The Japanese committed their best surviving naval air units to the latter struggle and lost them. But they proved unable to replace them in part for the want of fuel, technological limitations, and bad doctrines. Literally hundreds of half-trained pilots went down in the Battle of the Philippine Sea of 1944, to cite but one of many samples.

Yet, there were also some classical OCA operations against Japanese bases in New Guinea before then, and the Southwest Pacific campaign might even be seen as one designed to capture air bases with ground forces acting in support of the main striking arm—the air forces. Again, the need for escort was demonstrated there, and the length of the leaps that Gen Douglas MacArthur's forces made was usually determined by the range of the fighters available.

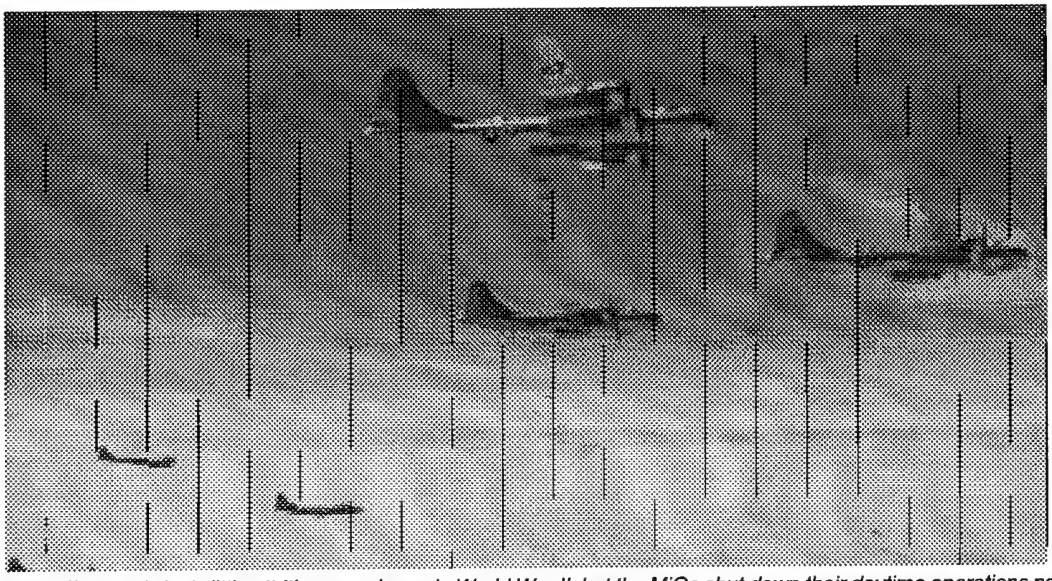
Judgments

By the time the B-29 attacks on the Japanese homeland started, the two Japanese air forces (army and navy) were too weak to do much about them, even if they somehow could have been persuaded or coerced into cooperating with one another. The bomber losses over Japan were but one-third of what they had been over Europe. Too, the Japanese training system had degenerated to the point where nearly half of their losses were noncombat—getting lost or crashing on landing and the like. The Allies by midwar enjoyed a substantial qualitative and quantitative advantage in aircraft and weapons, and though the Western organizations were hardly more unified in command than the Japanese, there did seem to be more unity of effort through cooperation.[41]

It has seldom happened that victory is so complete that the winner has complete access to his victim's country—and even to his archives. That did happen with both Germany and Japan in World War II. Even that, though, does not reveal a picture that is absolutely complete and absolutely true. Often, the defeated will tell the victors what the latter want to hear. Often, the investigators will somehow reveal to the defeated that which they want to hear. Often, much of the desired data is lost in the final fires. But the USSBS is about as valid feedback as one ever gets from wars. Its final judgment on air superiority in World War II was expressed thusly: "The German experience suggests that even a first class military power—rugged and resilient as Germany was—cannot live long under full-scale and free exploitation of air weapons over the heart of its territory. . . . The significance of full domination of the air over the enemy—both over its armed forces and over its sustaining economy—must be emphasized. That domination of the air was essential."[42]

The Battle for Command of the Air in Korea

At the time of the USSBS report, few people thought that any war in the future would be anything but a total war. Fewer still thought that our wartime ally, the USSR, would soon be our enemy—and that before the decade was gone, she would explode a nuclear device. And fewer yet suspected that we would again be involved in an overseas war before the air-



B-29s suffered relatively little attrition over Japan in World War II, but the MiGs shut down their daytime operations near the Yalu River in Korea.

craft with which we had fought World War II had worn out.[43]

Yet, we were back in combat in Korea before the fifth anniversary of V-J day. The tiny North Korean air force was wiped out in short order, but soon the People's Republic of China, now the second great Communist state, had intervened in the war. Airpower was a disappointment in Korea to most airmen. But it was not because of the want of air superiority. Most of them felt that we enjoyed more or less complete superiority not only over the battle lines but all the way up to the Yalu River. It is true that there were some pretty fierce air battles, by then all jet, over the northernmost reaches of North Korea. However, the United Nations (UN) forces seemed to have a free ride all over South Korea and almost up to the northern borders of North Korea.[44]

Many interpretations of the frustrations with airpower rest upon the notion that the new form of limited war denied UN forces the possibility of conducting an OCA campaign against the Communist air forces on the ground. Rather, they had to depend wholly on the air battle and to do so at a long range from friendly air bases and in the enemy radar environment. That yielded three great advantages to the enemy: numbers, the ability to refuse battle, and ground-control intercept direction by radar.[45] Too, the Chinese air force had MiG-15s that were surprisingly competent in some ways, even in comparison to the US F-86 Sabre, which did most of the air combat on the UN side. Until very late in the war, American airplanes were armed only with .50-caliber machine guns, whereas the MiGs had cannons—with much heavier projectiles, albeit with a lower rate of fire. Missiles were not on the scene yet for either the air or the ground defenses—although ground fire did impose many casualties on UN aircraft.

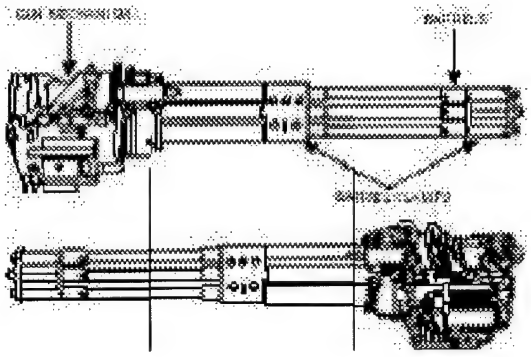
The war did have an OCA dimension to it, notwithstanding the fact that the rules of engagement (ROE) prohibited the B-29s from crossing the border and the MiGs made it too dangerous for them to do so in any event (in daylight). The Chinese did, however, try to extend their base structure southward to increase their pressure on the interdiction airplanes in the north and perhaps to provide some air support to their troops in the line. However, the B-29s and fighter-bombers suc-

cessfully denied that extension by their continual attacks on bases under construction.[46]

The organization of airpower in the Korean War was anything but centralized. The Air Force did create a joint operations center and won the cooperation of the other services in it, but that had little effect on the air battle. The air combat in MiG Alley up at the Yalu was largely an Air Force affair, as the Navy and Marine Corps did not yet have fighters that were at all competitive with the Communist jets. So, the lack of centralized organization did not matter much for the air superiority battle.[47]

In the end, the judgment was that the superior combat experience among the American flyers was the decisive thing in generating the overwhelming kill ratios against the MiGs. The Sabre was not superior to the MiG-15 in some important respects. Its armament had a much higher rate of fire, but the Communist cannons had a much larger projectile weight. The MiG also had a weak gunsight, a small ammunition load, and guns that often jammed.[48] The official organization certainly had little to do with the ratio. The Communists had the advantage in C^2 in their own ground-controlled intercept (GCI) environment. They also had the ability to refuse battle and a large numerical advantage. So, there is little left but combat experience to explain it. And that was largely fortuitous. Only five years had passed since World War II, and many of the seasoned veterans of that conflict were still in good shape and on active duty or in the reserves.[49] Perhaps all that led to complacency in America—especially in light of the fact that few came away with any thought of ever again engaging in a limited war on the Asian mainland.

In the years immediately following Korea, the commander in chief and the secretary of state were telling the country there would be no more Koreas. Although fighter and ground-attack aviation were never ignored altogether, the emphasis was very much on massive retaliation. It was the heyday of Strategic Air Command (SAC), and for all others it seemed that the only way to get funding was to acquire a slice of the nuclear pie. Still, it was during the Eisenhower administration that some important things were done that affected US conventional war capabilities. The Forrestal class of aircraft carriers came on the line—the Navy got its supercarriers after all. The C-130 rolled out in 1956 to become one of the most successful tactical aircraft programs ever. One of the best nonnuclear weapons in history, the M-61 Gatling gun, got its initial operational capability (IOC) in 1958 aboard the F-104 and F-105. Too, AAMs appeared for the first time, and one of them—the AIM-9 Sidewinder—got its initial kills aboard Chinese Nationalist F-86s that same year.[50] Before Eisenhower left office, the first SAM kill was achieved when a US U-2 was brought down over Russia by an SA-2. That these things would work a substantial change on the world of air combat was only dimly perceived.



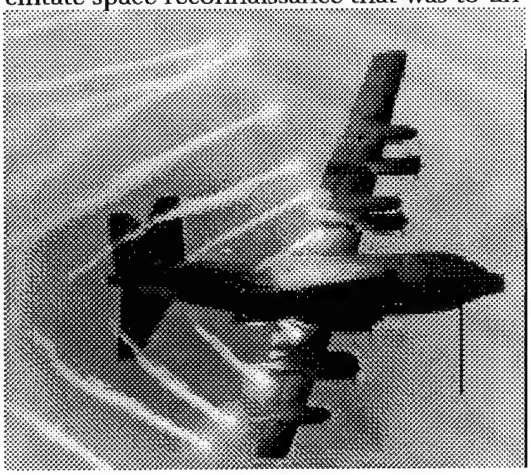
The M-61 Gatling gun came on the line in 1958 and still equips practically all US fighters except the Marine Corps Harrier, Air Force F-117, and Air Force A-10 Warthog.

History may record that in one respect, the Eisenhower administration's foresight was crystal clear—the space part of air and space superiority. The German combat employment of ballistic missiles in World War II even while General Eisenhower was campaigning across France set the world thinking about the future of space and space weapons. Soon after, both RAND and the Scientific Advisory Board were declaring that satellites and

intercontinental ballistic missiles (ICBM) might soon become practical.[51]

The remarkable thing about the initial space policy was that Eisenhower, himself a military man, chose the "freedom of the seas" rather than the "command of the air" model to be sought as humanity first extended its military activity into space. Well before anybody had orbited anything in space and before he could have had an inkling that the Russians would do so first, President Eisenhower established the policy of freedom of space–similar to freedom of the seas. A part of that was his "open skies" proposal at the summit of 1955 and his whole effort to keep military space and civilian space activities strictly separated–and to give the latter a commanding role. His whole effort was greatly facilitated by the fact that the Soviets under Khrushchev launched sputnik without any attempt to get permission for overflight, and the satellite clearly flew over US territory repeatedly and with impunity.[52]

So, well before Gary Powers was shot down in the U-2 in May 1960 for violating Soviet airspace, the Eisenhower administration had established the freedom-of-space idea to facilitate space reconnaissance that was to underwrite the viability of both deterrence and arms control. At first and for a long time, the space program clearly had a strategic orientation although it sometimes had tactical effects. Among its early achievements were the revelations that neither the "bomber gap" nor the "missile gap" had any basis in fact. That was an important factor in the leveling off of the US strategic nuclear order of battle, which in turn led to stabilization of the nuclear arms race.



Although the emphasis in the 1950s was on strategic nuclear warfare, tactical doctrine and technology were not ignored; the C-130 has been used for all sorts of tactical missions as a gunship, bomber, airborne delivery of troops and resupply, medical evacuation, and many other functions. Starting in 1970, portable infrared missiles like the SA-7 became a threat, and one countermeasure was the launching of flares.

Space-based weather forecasting began to have a significant effect on the Vietnam War. Communications technology was so facilitated by satellites that it actually became an impediment in some cases. During the evacuation of Saigon in 1975, for example, the presence of a satellite communications terminal in the Defense Attaché Office (formerly the Military Assistance Command, Vietnam [MACV] headquarters building) was a godsend. Ultimately, all other links with the outside world were broken. But satellite communications made it so easy for many leaders everywhere to reach the few officers responsible for marshalling the evacuation that they hardly had time to attend to their urgent duties–they were so busy answering queries from every headquarters between Nakhon Phanom and Washington.[53]

Two years earlier, during the Yom Kippur War, the superpowers had been better informed as to what was going on at the battlefront than were the combatants themselves. In part, this was due to high-altitude reconnaissance from the SR-71 and the Foxbat. In part, too, both sides were getting satellite photographic intelligence that was instrumental in bringing a truce to the fighting–and to the stabilization of Middle East politics ever since.[54]

Up to that point, then, I suppose that one could argue that the United States did not have space superiority. She could operate freely there herself but could not deny the adversary the free use of the medium. Still, the fact that the Soviets could also work there with impunity was not altogether negative in its impact on US national interests. We now turn to a review of an important new book as a vehicle for discuss-

ing the Vietnam War phase of the history of air and space superiority theory and doctrine.

"Clashes": A New View of the Struggle for Air Superiority over Vietnam

So the United States entered the war in Vietnam in stages without much thought as to what her real objectives were, nor how she would get out. Her Air Force and Navy had emerged from Korea without much change in their doctrines on air superiority and probably had not fully articulated the implications of the subsequent new technology of AAMs and SAMs. It is probably also true that the services had not much considered that relationship between guerrilla war and air power, nor were they as advanced in electronic warfare (EW) as they might have been. At the outset of Vietnam, precision-guided munitions (PGM) technology had hardly advanced at all (in principle) over the Azon guided bombs that had been used in Korea. Col Marshall Michel has now come forth with a new book* explaining how all that came to pass and how the performance might be improved in the future.

Thesis

Michel makes a persuasive argument that is not altogether new. The US air forces—Navy and Air Force—held their own for the early part of the war, once they found technical answers to the new SAM threat to their command of the air. But things turned sour during 1967, in part because the Vietnamese themselves were learning, and the technological responses were having a diminishing effect against them. Operation Rolling Thunder was shut down in the spring of 1968, and in the months that followed, the Navy went to work and repaired its training program with its Top Gun operation; the Air Force made some technological improvements but then did not do much with the air-to-air training effort. The result was that when the Linebacker operations came in 1972,[55] the Navy fared much better than did the Air Force. Only since then has the Air Force repaired the training system with such things as Red Flag, changes at the Fighter Weapons School, and other programs.[56]

Is the Author an Authority?

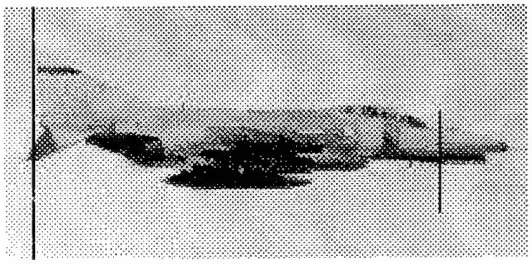
Colonel Michel has fine credentials for doing such a book. A native of New Orleans, he came into the Air Force in 1966 and flew combat sorties—more than three hundred—out of Udorn, Thailand, some in the RF-4 and others in the F-4E. He later spent time as assistant attaché in Israel and on the Israeli desk for the Joint Chiefs of Staff (JCS). He then flew a tour in F-15s at Langley Air Force Base (AFB), Virginia. Michel later was on the NATO staff and retired in 1992. His writing style is excellent, and though he seems knowledgeable on naval aviation, the vast preponderance of his documentation is of Air Force origins. He has a nice combination of practical experience and professional study, but it is probably fair to say that his search of the literature on air and space superiority was competent but not exhaustive.

One of Colonel Michel's degrees is in English from Georgetown University, and that shows in his writing. Another, in international relations, is from Catholic University. He was also a fellow both at the Harvard Center for International Affairs and at Tel Aviv University. He is now working on another book, this one focused on Linebacker. It does seem to me that he makes one assumption that there is in the Air Force an inverse relationship between rank and the ability to profit from constructive criticism. A second might be that there is a direct relationship between high rank and the fragility of egos. Perhaps a third is that commanders and other high-ranking officers are omnipotent. I have no evidence that Michel was ever a flying-unit commander, and those apparent assumptions make me suspect that he was not.

*Clashes: Air Combat over North Vietnam, 1965–1972 (Annapolis: Naval Institute Press, 1997).

The Argument

Clashes explains the disappointments of the battle for the command of the skies over North Vietnam as arising from a variety of factors, the most important of which is unrealistic air combat training before and during the war. Among the others, though, were equipment shortcomings. The main air-to-air fighter on the US side was the F-4, much larger than the MiGs it fought. That, plus the fact that it had a smoky engine made it less likely that the American crewmen would see their enemy before they themselves were spotted. Too, the design of the F-4 (originally intended to be a fleet-defense fighter against nonmaneuvering, large targets) yielded poor all-around visibility, which was especially bad toward the rear—the most likely avenue of enemy attack. Further, in the F-4C—the Air Force version—the cockpit layout was not "user friendly." The switches were placed hither and yon, which made it difficult for the crews to manipulate them at the same time they were keeping watch for enemies outside the cockpit. Finally, the aircraft did

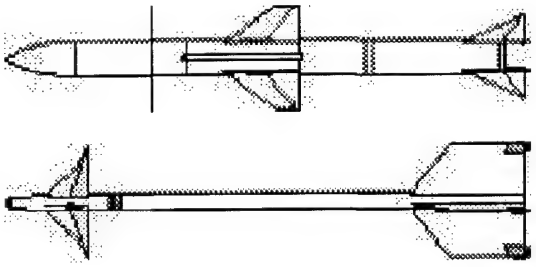


An Air Force F-4G for the suppression of enemy air defenses (only the F-4E had a gun installed)

not have an internal gun in either the Navy (F-4B) or the Air Force versions (F-4C and D). Here, Michel seems to imply that the shortcomings were somehow the fault of the senior leadership in the Air Force.

The air-to-air weapons were also highly ineffective. Radar missiles were particularly difficult to set up in the heat of combat, and one had to keep the F-4's radar pointing at the target for the entire flight time of the missile.[57] The AIM-7 Sparrow (radar guided, semiactive)[58] was large, about a quarter of a ton, and it had a smoky engine—both factors making it easier to spot and evade with violent maneuvers. Too, when the Navy first developed the missile in the 1950s, solid-state electronics had not yet appeared, and miniaturization of electronic parts had just begun. Thus, the early versions of the Sparrow were far less reliable than desired. Also, the ROE required a visual identification of the target before firing, which greatly inhibited the use of the AIM-7s. So, in the end, the kill rate with them in Vietnam was down around 10 per cent, and two-thirds of them malfunctioned when Air Force crews tried to fire them.

The AIM-9 Sidewinder was a heat seeker (infrared [IR]) also developed by the Navy in the 1950s. The IR system was much simpler than radar missiles and thus more reliable. But it also was dependent on earlier-generation electronics and consequently very subject to failure. Too, its rocket motor was exceedingly smoky,[59] and its ability to make a high-G (very sharp) turn was limited—so it could also be avoided if spotted in time. Still, the Sidewinder kill ratio was only about 18 percent. Colonel Michel does explain,



AIM-7 Sparrow (top) and the AIM-9 Sidewinder (bottom)

though, that one of the reasons the Navy achieved a better record was its greater reliance on the more reliable and simpler-to-use IR missile than on the radar weapons. (The Navy's best-trained air-to-air units flew the

F-8, which was not equipped to fire the radar missiles.)

None of the Navy's F-4s ever used a gun in combat—they never acquired a model with an internal weapon and could not use the external gun pod because it would have eliminated the use of the centerline external fuel tank, which would have been unacceptable for carrier operations. Even before the war, the Air Force had undertaken the development of an external gun pod containing a 20 mm weapon. It turned out to be a good piece of equipment, but it did limit the performance of the airplane because of its drag, and it never was as accurate as an internal gun. The F-105 had such an internal gun from the beginning and made some of its kills with that weapon—it did not have a radar-missile capability, but it also made some kills with the Sidewinder.

Michel demonstrates that another reason for the Navy's superior record was the excellence of its shipborne GCI, called "Red Crown." Even the Air Force crews, when they were close enough to the coast, avowed that radar control and warning was superior to the Air Force provisions in the "College Eye" radars aboard C-121s or the "Teaball" warnings coming from a ground facility at Nakhon Phanom.

Finally, Michel explains that the Navy had the easier problem in many ways. Its operating areas were on the coast, requiring very little time over enemy territory. But the Air Force aircraft had a long drag from Thailand across the whole of North Vietnam to the targets in the eastern part of the country. Thus, Air Force crews were under enemy surveillance and fire for much longer periods. Also, he explains that the Vietnamese deployed the MiG-21s against Air Force formations more than against the Navy, and the latter was faced with the obsolescent MiG-17 much more frequently than was the Air Force.

Nevertheless, Michel denies that that situation excused the Air Force for its inferior record. His main complaint was the inadequacy of air combat training before and during the war. This he lays at the door of senior leadership, although he does allow that there was a substantial conservative streak among the teachers at the Fighter Weapons School. Their approach to training was much too conservative, and the air-to-air portion of the program consistently received too little emphasis. A part of this arose from the heavy concentration on the nuclear-strike mission in the years following Korea. Also, many commanders were too hypersensitive to the risk of accidents to permit truly realistic air combat training. Then too, the conservatism of the senior generals made the Air Force stick with an inadequate tactical formation—the "Fluid Four"—long after the Navy had demonstrated the superiority of its "Loose Deuce." Finally, the conservatism of senior Air Force leaders also caused them to cling to a technological explanation for the disappointment after Rolling Thunder—that the poor kill ratios were to be expected because we were operating in the enemy GCI environment without radar warning and control of our own. But the Navy was usually able to employ the radar facilities of ships standing hard by the shore. The result was that the Navy turned to briskly and built up a splendid "Top Gun" training program[60] while the Air Force sought only technological solutions until after Linebacker exposed the unwisdom of that.

Evaluation

My estimate is that Clashes is the best book in print on the subject. But it is not perfect. The sources used are largely limited to Air Force documentation and only a few of the most prominent published works on naval aviation. Michel uses the Air Force's Red Baron studies very extensively. There are some inferences drawn that may not come from the documentation but from his crew-member experience. One example is that the absence of a gun from the design of the F-4C was the fault of Air Force senior leadership. I suspect that the whole thing is much more complex than Michel imagines. The way that Lt Gen John J. Burns explains it is that the A-7, F-4C, and F-111 were forced upon the Air Force as a package, at least insofar as some of their design features were concerned, by Secretary of

Defense Robert McNamara. He came to office determined to improve accountability and to reduce the inefficiencies arising from service parochialism.

One dimension of this was to get the services to employ more "commonality" in their aircraft-acquisition programs. The Navy did not require an internal gun for the F-4 because it was designed to be a fleet- defense interceptor. McNamara wanted the airplane to equip both services, and the initial difficulties with the F-105 helped him achieve that. When the Air Force was finally persuaded to accept the F-4, the secretary put strict limits on the modifications that would be made to it to make it suitable for Air Force service. One that was permitted was the addition of a duplicate set of controls—which were not in the Navy version—to the back cockpit. The Air Force also wanted an internal gun, but the Office of the Secretary of Defense would not permit it—until after combat over Vietnam proved its essentiality. By then, it was necessary to come out with an entirely new model—the F-4E—to accommodate it. The side-by-side seating in the F-111 is another example. The visibility from the cockpit of that airplane is poor, and the Air Force could not have tandem seating because that would have made the airplane too long for aircraft carrier elevators. In the end, the Navy never purchased any 111s.[61] The point is that the generals in the Air Force are not as omnipotent as most flyers, including me, have traditionally thought them to be. That is as it should be in a democracy, even when it results in some wrong decisions from time to time.

Another standard lament of crew members, especially those in the fighter force, is that the generals of the pre-Vietnam days were too timid to permit realistic air combat training. General Burns shares that opinion with Colonel Michel.[62] Doubtless they have a point, but what is often left out of that lament is that the accident rate certainly did come down greatly during the late 1950s and early 1960s. It seems to me that there was a certain devil-may-care/boys-will-be-boys attitude among the flyers in the early fifties, but the "buzzing" of girlfriends' houses was much diminished after 1955, when the service began to exert more professional discipline on the officer corps. Indeed, more lives may have been saved in the ensuing decade than were lost in the skies over North Vietnam—just another dilemma of high command, I suppose?[63] Finally, we came away from the war against Kim Il Sung with a stout "no-more-Koreas" attitude that necessarily led to emphasis among fighters on continental air defense against high-altitude, nonmaneuvering bombers.

In the end, though, those comments are only quibbles. Again, I say that Clashes is, to my knowledge, the best thing in print on the air war over North Vietnam, and APJ's audience should give it a high place on their reading list. It may not be the last word, though, because there is a book in the offing by a long-time member of the Air Force History and Museums program, Dr. Wayne Thompson, that will appear in the next year or so; his book should supplement if not supercede Colonel Michel's fine work. Thompson, who has done much creditable work there over the last couple of decades and was a prominent member of the Gulf War Airpower Survey, has completed the draft of Rebound: The Air War over North Vietnam, 1966-73. It should be in print within the next year. Rebound and Clashes are both positive signs that airpower history is maturing beyond the histrionics of the 1960s.

Air Superiority after Vietnam

For a number of years after 1972, the American air forces did not do much air fighting. Several times, foreign air forces got involved in combat, but they all were so limited that what emerged was largely a set of speculations rather than any "lessons."

Before the final American humiliation in Vietnam, the Israeli air force (IAF) executed a campaign that added to its already-great mystique. In the opening hours of the 1967 war, it destroyed the Egyptian air force in an OCA

operation that would have made Douhet proud. The war began with a preemptive strike on Egyptian airfields and radar sites. More or less complete surprise was achieved, and restrikes were conducted with impressive dispatch and minimal ground times. At the end of the campaign, the Israelis claimed to have destroyed over four hundred Arab aircraft, close to 90 percent on the ground. Although the missile war was in full swing in Vietnam at the time, it seems that all the air-to-air kills on both sides came from guns. Atoll air-to-air missiles were fired, and one did some damage—but apparently no aircraft was brought down by a missile. The Israelis dominated the air battle, but by far the greatest damage was done by the attacks on the enemies in their nests.[64]

The dramatic IAF victory had multiple effects. First, it set off an aircraft-shelter building program not only all over the Middle East but also among the NATO and Warsaw Pact air forces. Second, it accelerated the Arab move into ground-based missile defenses, not only around their air bases but also ultimately leading to the building of a formidable missile belt along the Suez Canal. Third, it imposed such a humiliation on the Arabs—and they lost so much important territory—that it probably made another war inevitable. Finally, the additional buffer space gained by the Israelis and the ease of their 1967 victory may have lulled them into a false sense of security.

Notwithstanding the splendor of Israel's victory, the Six-Day War may not have been the IAF's finest hour. According to Michael Howard, doctrine is always wrong, and he whose doctrine is the least wrong and whose system is the most flexible will win. This is so because he will be able to compensate for the wrongness more rapidly than can his enemy.[65]

The war of attrition from 1967 to 1970 taught the Israelis that a preemptive, Douhet-like strike would not likely work again. In any event, it would be too costly in terms of world opinion—especially so in the United States. By 1973 there were missile batteries around the most important Arab bases and along the Canal, and the IAF had largely been reequipped with American aircraft, principally the A-4 Skyhawk and the F-4 Phantom. There were plenty of signals of an impending attack, but the Israelis did not believe them. Possibly that was because they did not understand that the Arabs no longer had the destruction of the Israeli state in mind but were going for more limited objectives. Further, it possibly was because of complacency, and certainly because of a false assumption that there would be 48 hours advanced warning.[66]

This time, there would be a more complex and closer-run contest for the command of the skies. The ground-based element was to play a much larger part than theretofore. The firm doctrine that air superiority has to come first was compromised for the sake of ground support, especially on the Golan Heights, where it seemed for a while that the Syrians were about to break through to the sea. It was a classical case of a ground emergency serious enough to divert airpower away from its primary task—the winning of air superiority as envisioned above in the passages on the new AFDD 1. Too, it was a wonderful demonstration of the flexibility of airpower, in that the IAF was switched from the Sinai Desert in the south to the Golan Heights in the north with blazing speed. And it seems that it saved the day in so doing. The cost, though, was enormous. The Israelis had reequipped their forces with aircraft but had not gone as far as they might have in the acquisition of PGMs and electronic countermeasures (ECM) pods. However, in this war there were significant numbers of kills by both AAMs and SAMs. Further, the shoulder-fired antitank missiles had a field day in the biggest tank battles since Kursk in 1943.[67] Howard suggests, then, that one does not gauge the true measure of an air force when things go perfectly according to plan, but when the plan becomes a shambles and the force nevertheless has the presence of mind and flexibility to snatch victory from the jaws of defeat. If that is valid, then perhaps Yom Kippur is a better indicator of greatness than 1967 was.

The next air combats came in the Falklands War and the Israeli operations in the Bekaa

Valley, both in 1982. In the former, most of the air-to-air kills were by missile, and shipboard defenses seemed inadequate, notwithstanding some SAM kills. The British suffered painful ship losses and might have suffered many more if the safe-and-arm devices of the Argentinean bombs had worked properly (actually, it was improper launching tactics that prevented the devices from functioning as designed). In the latter case, the IAF proved that it had learned its lessons well. In company with the Israeli ground forces, the IAF managed to shut down the Syrian SAM system with impressive speed, extensive use of remotely piloted vehicles (RPV), and an air battle that went heavily in the Israeli favor. Both experiences suggested that the command of air and space would continue to be determined by some combination of surface attack and air fighting plus fire from ground guns and missiles. In the Falklands, AIM-9L Sidewinders were responsible for the greater part of the British air-to-air kills, and the very high success ratio suggested that reliability problems with that missile had been overcome. Practically all of the kills of the IAF at the Bekaa Valley were by missiles.[68]

The Navy and Colonel Michel were certainly right in saying that a part of the Rolling Thunder difficulty over North Vietnam arose from training, not technology alone. After all, there is no evidence that the Communist weapons were any better than the American ones. The Navy moved quickly to establish a rigorous, specialized air-to-air training program (Top Gun) for its F-4 pilots, and that seemed to have immediate effects.

As noted, Michel argues that the Air Force leadership did not want to admit a weakness and blamed it instead on technology. Perhaps that is true, but it is also true that there were but four years between the bombing halt and Linebacker—and that is not all that much time to get a major training operation started. Soon after, though, the Red Flag exercise was set up on the ranges at Nellis AFB, Nevada, complete with electronic tracking and recording methods and elaborate video debriefing systems. The range was equipped with accurate simulations of practically all of the ground threats the West was liable to face, and American and allied units were cycled through the program at frequent intervals.[69]

The Air Force Fighter Weapons School was collocated with Red Flag and played an important role in the reforms. It brought in select instructor pilots from field units and subjected them to an intense, unusually rigorous training program. If those students graduated, they went back to their units with a special status and expertise to pass on the latest thinking about air combat to their colleagues.[70]

Additionally, again following a Navy lead, elaborate air combat maneuvering instrumentation (ACMI) systems were installed at various locations around the United States and at some places overseas. Although not as elaborate as the installations at Nellis, they nevertheless were able to accurately track and record fairly complex mock air battles over their local ranges. Then the recorded material was used in a new and rigorous debriefing program that vastly improved the realism and effectiveness of continuing training.

For some time after the fall of Saigon, the Air Force maintained both a Soviet Awareness Group and an aggressor squadron. Both were charged with becoming expert in Soviet culture, technology, and doctrine and with traveling about the United States to pass on their expertise to users. The aggressor squadron was equipped first with T-38s and later with F-5s so as to permit dissimilar air-to-air training. Practice air combat maneuvering between F-4s had limited effects in preparing US crews to face MiGs, and the F-5s were a fairly close approximation of the MiG-21. According to Michel, the results were at first much in the favor of the F-5 aggressors, but fairly soon the line crews were able to reduce the gap.[71] Added to this was a new, more aggressive policy toward home-unit training that many fighter pilots feel was the most significant factor.[72]

Finally, there were some highly important reforms in areas other than the air-to-air battle that affected it in a significant way. One was development of the stealth bomber—the F-117. That was important because it was so hard to detect on radar that if it flew at night, the support package needed for other attack-

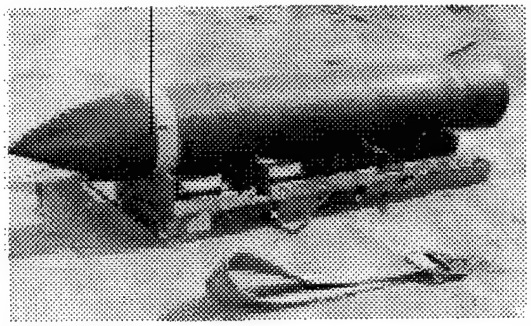
ers to protect them from the stalkers was unnecessary. Another item was that the increasing availability of PGMs and their substantial advantage in accuracy over unguided bombs meant that a strike package containing few "shooters" would administer a higher level of damage to the target than would have been the case in Vietnam. That meant that the United States could afford to include many more support aircraft to protect the "shooters" from the enemy airborne and ground-based stalkers. It also meant that easing of requirements for air-to-ground training released more time for air-to-air practice.

By the 1990s, although we had not yet deployed lethal instruments in space, the nonlethal ones were making a substantial contribution to air and space superiority. Certainly, space-based weather reconnaissance contributed in many ways, even in the days of the Vietnam War. By 1990 it yielded a substantial advantage in planning attacks and providing for force protection. Space assets also were a large help in reconnaissance and the air-"recce" units had all but disappeared from the forces. Also, in conjunction with the new airborne warning and control system (AWACS) in the jet aircraft that replaced the "College Eye" in the C-121 "Connies" of which Marshall Michel complained, space assets were making warning and battle damage assessments (BDA) much more effective than they had been. Although it was to prove impossible for the air campaign to completely shut down Saddam Hussein's communications, their degradation, combined with the enormous benefit of the new US space-based communications links, yielded another huge advantage.

Finally, the Goldwater-Nichols Department of Defense Reorganization Act of 1986 had greatly strengthened the role of the chairman of the JCS and the area commanders in chief (CINC), and that was arguably a substantial step in the direction of the traditional Air Force organizational and doctrinal preference.[73] Legislation and the policies growing therefrom made it not only feasible but also advisable for the CINCs to appoint a joint force air component commander (JFACC).[74] This seemed to promise that the ideal of centralized control of airpower at the theater level by a coequal air commander would finally be realized.

The Gulf War

Some people have suggested that any old strategy would have brought the Iraqis down in 1991. The implication might be, then, that the battle for the command of air and space against a paper tiger means little for the future. It is true that it was a lopsided victory. The OCA part of the campaign in its air-to-ground dimension worked like a charm. The F-117 did always get through.[75] The degradation of the Iraqi detection and C^2 systems was quickly accomplished, and it certainly added to the ease with which the air-to-air part of the campaign was completed. The F-15s cleared the skies of the few enemy aircraft that ventured forth, and the coalition suffered no more than one suspected air-to-air kill. The combination of stealth as well as lethal and nonlethal SEAD largely suppressed the SAM threat and in turn permitted coalition aircraft to do their missions at medium and high altitudes above the AAA and shoulder-fired SAM threats. The spread of PGM technology enabled them to actually hit targets from those altitudes. They also made feasible what John Warden calls "parallel attack" (as opposed to sequential).[76] That empowered the coalition to overwhelm the defenses as a synergy arose from the destruction of so many OCA targets nearly simultaneously.



BLU-109 penetrating bomb body, two thousand pounds

The stout aircraft shelters built by Iraq and many other nations in reaction to the "lessons" of the 1967 Arab-Israeli War proved useless—except perhaps as magnets attracting PGMs to empty shelters. The combination of precision and penetrating bomb bodies made it so.[77]

Added to those great advantages was the fact that the coalition enjoyed a huge information edge by virtue of an extreme imbalance in the access to space resources—the Gulf War was called the first space war. In short, the coalition enjoyed air and space supremacy.[78] This time, the adversary did not even enjoy the access that the Arabs had in the Yom Kippur War through the Soviets. The cold war having ended, the Russians were no longer the patrons of the Iraqis, and the only access Saddam Hussein might have had was through commercial space assets. But was that imbalance just a flash in the pan, or can we hope for more to come?

Missiles accounted for practically all of the air-to-air kills in the Gulf War. The reliability and kill ratios for the AIM-7s and the AIM-9s were much better than they had been in Vietnam, and the AWACS performed much better than had College Eye in the 1960s and 1970s. There really was not that much of an air-to-air battle, certainly not in the form of dogfights. The result was that the major improvements made in the F-15C design for the sake of air-combat maneuvering were not fully tested in combat. The same is true for the F-16, which had been designed as a dual-role fighter, although with much more attention to air combat than had been the case with the F-105 and the F-4. The great advantage that the United States had in air refueling made the maintenance of continuous combat air patrol feasible. This had advanced considerably since the Vietnam War by the acquisition of the KC-10, which helped greatly with refueling deployment (and with airlift). Further, the reengining of the KC-135 fleet to create the R model greatly enhanced its ability to sustain extended combat operations.[79]

There was a good deal of self-congratulation in the aftermath of the Gulf War over the fact that the Goldwater-Nichols Act worked. The centralization of the C^2 of theater air forces was really accomplished. Later, though, some people argued that the reason it appeared that way was the accommodating personality of the JFACC, Gen Charles Horner.[80] They argued that his great preponderance of air assets permitted him to avoid the hard choices and to allow all the air forces (save perhaps his own US Air Force) to fly whatever missions they wanted. As with the campaign in France in 1944, when one has wall-to-wall airpower, doctrine does not matter very much.

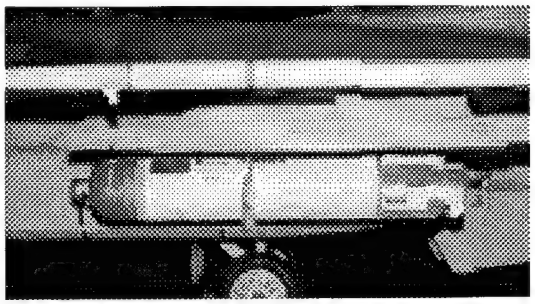
Since Operation Desert Storm

Many critics were quick to say that the conditions in the Gulf War were nearly ideal for airpower.[81] That was true. Still, spells of bad weather slowed the air campaign. Laser-guided bombs (LGB), IR weapons, and television guidance all required at least a modicum of visibility. Since the Gulf War, the United States has moved to close that weather sanctuary, just as she has eliminated the shelter of darkness.

The Joint Direct Attack Munitions System (JDAMS) is going into service at this writing. It uses a guidance system that is not quite as precise as laser or television guidance, but one that can operate in all weathers—as long as there is good intelligence on the location of the target. It operates with an inertial kit that steers the bomb toward its objective, aided by a Global Positioning System (GPS) receiver that takes signals from space to correct the inertial trajectory and deliver a circular error probable (CEP)[82] of about 15 meters (for some LGBs, the CEP is about three meters). This accuracy is fine for the vast majority of targets—if a two-thousand pounder falls within 15 meters of a soldier in the open, his day is done. This can be done from above the clouds and at medium altitude, either day or night. Another beauty of it is that the cost of each JDAMS kit is only $14,000—far lower than that of a laser kit, which itself is far cheaper than all other forms of guidance. Some peo-

ple argue that the day of the "dumb" bomb appears to be done.[83] The implications of this for the air-and-space-superiority battle is that far fewer shooters will be necessary to destroy a given set of targets than heretofore; consequently, it will be far easier to protect them from the stalking birds. Too, early in the next century, it is anticipated that an autonomous seeker[84] will be developed for some of the JDAMS so that when the last increment of precision is indeed required, JDAMS will be able to deliver it. The F-117 will be able to carry two of these weapons in the two-thousand-pound size, and a smaller version of one thousand pounds is being developed so that it may be carried inside the weapons bay of the oncoming F-22. That is necessary to preserve its stealth qualities, although where that is not necessary, the Raptor will be equipped with pylons to carry the larger bombs externally.[85]

An attractive feature of the JDAMS we noted was its moderate price. But another development has been designed especially as a strap-on kit for the standard munitions dispenser. It does not contain the GPS feature and relies wholly on an inertial system that takes out the effects of the wind when the weapon is dropped from medium altitudes. It costs about half the price of a JDAMS kit, and initial production will take place in 1998. Called the wind-corrected munitions dispenser (WCMD), it will be capable of carrying the standard submunitions, including the sensor-fuzed weapon, mines, and the combined-effects munition. It is not quite as accurate as JDAMS, but extreme accuracy is not required for scatter weapons.[86] It would play a part in the battle for command of air and space because submunitions are especially effective against SAM and AAA sites or aircraft in the open.



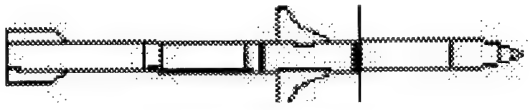
Wind-corrected munitions dispenser loaded on port pylon of Air Force F-16

To be able to fire at an enemy stalker who cannot reach you is a capability longed for since ancient times. The Air Force has been the lead service in the development of the JDAMS; the Navy is leading another development with a common guidance system—the joint standoff weapon (JSOW) system, also designed to fire at an enemy who cannot shoot back. Its IOC is just around the corner. It is a glide bomb with wings that extend after release. The idea is that the weapon will be used at a distance to degrade the enemy air defense systems to make it safe for aircraft to go in with JDAMS and even dumb bombs to strike other targets. It too will be released from medium altitude or above and from a much greater distance than with JDAMS. Initial versions will be equipped to deliver the various submunitions in the inventory, such as the combined effects munition (CEM) or Gator mines.[87] One version is being built to deliver a unitary bomb as well. Later phases of the program in the next century will marry the GPS/inertial guidance system with a terminal seeker that will give some of the JSOWs the same precision that LGBs now enjoy. Usually, scatter weapons like the CEM have no need for the last increment of precision, so there will not be the need to use up an expensive seeker and processor for them. Still, JSOWs will be more expensive than JDAMS and, therefore, will not be procured in as many numbers.[88]

Still more expensive than the JDAMS is the joint air-to-surface standoff missile (JASSM).[89] There typically are some nodal points in an IADS that are vital but too dangerous to approach, even to JSOW ranges. Before the fall of the USSR and the Warsaw Pact, the services had a joint program for a similar missile with stealth characteristics that were deemed necessary to attack such targets. However, to get the last increment of stealthiness would have been an expensive proposition. When the Communist empire fell, we decided that that

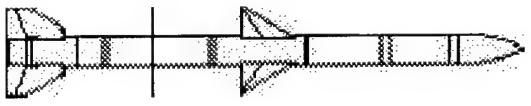
requirement could be relaxed a bit, so the original program was cancelled (for that among other reasons), and JASSM was designed for the same mission at about half the cost.[90] It will nevertheless be expensive and not ready until the next century, when it will become the longest-range standoff weapon available for Air Force fighter aircraft.

Another part of the armament program that is aimed at similar effects is the high-speed antiradiation missile (HARM)—but it does not have the long-range JASSM. We saw that the stalking birds in Vietnam had a huge advantage working inside their own GCI environment, and HARM is designed to suppress the radars essential to that direction. It homes on radiation and travels at very high speeds in the hope of arriving at the antenna before the enemy operator can shut it down.



AGM-88 HARM

HARM was first used in the raid on Libya in 1986, and in the Gulf War it was not necessary to fire very many of them. The Iraqi controllers quickly discovered that emitting was hazardous to their health, so the mere presence of HARM shooters in the vicinity was enough to keep their radars off the air—which enabled the free passage of nonstealthy strike forces.[91]



AIM-120 AMRAAM

We saw above that substantial improvements were made in air-to-air weapons before the onset of the Gulf War. However, perhaps the most important one achieved its IOC only in September 1991 and could not be deployed to the Gulf in time to get a combat test. The advanced medium-range air-to-air missile (AMRAAM) had been underdevelopment for many years, and the goals for its program had been ambitious indeed.[92]

We have noted that it was necessary for US fighters over Vietnam to direct their radar missiles until they hit the target and that that was a disadvantage compared to the "launch-and-leave" characteristics of IR missiles. One of the AMRAAM goals was to develop a weapon that could guide itself to the target without the assistance of the launching aircrew after it departed the missile racks. That would permit the crew either to begin their escape or to launch other missiles at other targets before the first one had impacted. Yet another goal was to make the AMRAAM light enough to be used aboard the F-16, since the fighter force had more of these planes than any other. Most of the latter did not have any beyond-visual-range capability because the AIM-7 Sparrow needed a fairly sophisticated aircraft guidance system and the F-16 radar was inadequate.[93]

AMRAAM's weight is perhaps 70 percent of the Sparrow, and it is fully compatible with the avionics of the F-16. It has a higher speed too, and there is less smoke generated by its motor. Multiple AMRAAMs can be managed at one time by a single fighter, and one of their modes of operation is autonomous—they become launch-and-leave weapons. For all of that, though, the world of air combat is a hard one—it is difficult to stay ahead, and in some respects the Russians have better missiles—although the combination of stealth in the F-22 and the AMRAAM will likely be better than the combination of Russian fighters and missiles.[94]

If the threat of Russian fighters and radar missiles were not enough to keep one awake, then there have also been developments in the world of IR weapons and helmet-mounted displays (HMD) that will. In the days of Vietnam, as we have seen, it was necessary to drive up behind an enemy and maneuver into a moving cone behind his exhaust to get a lock-on and fire an IR missile. Such missiles have now been improved to the

point that they are all-aspect weapons. They can be fired from the forward hemisphere of the enemy, and they will home in perhaps on the leading edges of wings that have been heated by air friction—but more likely on the jet exhaust, which can be sensed even from the nose aspect.[95] But at first it was still necessary to point one's aircraft at or nearly at the enemy before the missile could be fired. By moving the sighting display to the visor on the pilot's helmet and giving the seeker on the missile itself a wide field of view (FOV), it can be launched at very large "off-boresight" angles—precious seconds before the enemy can fire one at our airplane.[96] The Russians and the Israelis have had such missiles and helmets for some time now, and they do have some limitations.[97] The F-22 will come equipped with a joint helmet-mounted cueing system and a new IR missile (AIM-9X), but that is not scheduled to gain its IOC until 2004.[98] Several European nations have missile programs also looking toward that kind of weapon/helmet combination.[99]

Another advantage of the IR missiles is that they are passive—that is to say, they send forth no electromagnetic emissions to warn the enemy that he is about to be attacked (some Sidewinders do have proximity fuzes that emit radio-frequency energy—and using the aircraft radar to measure range even with IR missiles can be a big help). The unfortunate part of it is that IR weapons are short range. However, the Russians and the US Navy (aboard its F-14s) have had operational infrared search and track systems (IRSTS), which enable them to spot other aircraft at considerable distances without turning their radars on. This has the potential to permit the first shot, as radars theoretically can be detected by radar-warning receivers at twice the distance that they can themselves identify the target (the energy has to make a round-trip for the attacker's antenna but only a one-way journey to the target's antenna). This may be especially troublesome in that the Russian AA-10 has a longer range than most other IR missiles; this capability might enable it to reach out and touch someone when combined with an IRSTS.[100] A well-established notion of air combat is that he who takes the first shot is very likely to win.

The Air Force has so far not specified an IRSTS for the F-22, although it tested some in the late 1980s. Apparently, stealth combined with a radar set that seems to be difficult to intercept is enough to make the inclusion of an IRSTS unnecessary. Such equipment already on Russian and late-model Navy fighters is soon to be included on other European aircraft. Too, it has other potential uses in which its passivity may help, such as finding a tanker without making emissions or identifying plumes from Scud missiles as they fire.[101] US fighters so equipped have a similar capability through their LANTIRN (low altitude navigation and targeting infrared for night) pods.[102]

But balanced against those technological gains has been a huge force-structure drawdown. The Air Force is now about a third the size it was at the height of the Vietnam War. In 1997 the enlisted strength of the Air Force was lower than in any year since Pearl Harbor except 1947. Continuing commitments in the Persian Gulf and elsewhere have created an operations tempo so high that opportunities for realistic training are often lost. Aggressor units are much diminished from what they once were.[103]

Additionally, there has been a huge overseas-base drawdown and a greater concentration of units in the continental United States. There has been some reorganization and consolidation among the major commands, and composite-wing experiments have been conducted. Work has been done on developing a doctrine and organization for quick redeployment overseas in the form of air expeditionary forces, but that has not yet had a large-scale combat test. Most of the plans associated with that call for the front-loading of air superiority assets in the redeployments, and doubtless it would be done better now than it was in Torch in 1942. But excessive confidence that our technological, doctrinal, and organizational cleverness will compensate for low numbers and the lack of bases and radar sites in the stalkers' backyards would make us victims of Michael Howard's lament. Doctrine is always wrong, and he who

can adapt to its errors after combat has revealed them will win. If the world turns out to be different from the way we picture it, will we be able to react more quickly than enemies now far less knowable than the Soviets were for 50 years?

A Century of Thinking on the Command of Air and Space

We are now in the twilight of the first century of the air age. What do we have to show for the huge intellectual effort that has gone into the development of air and space superiority doctrine? There has been little disagreement that we should command the medium. The rub comes when the discussion turns to the methods of doing so.

During World War I and the 1920s, in America at least, the emphasis was on the air battle. Different thinkers placed varying values on the offensive methods of fighting that battle. Douhet was among the earliest to assert that command of the air could be best won through attacks against ground targets. American thinkers moved toward that position in the 1930s but not all the way.

Soon after the onset of World War II, the limitations of the Douhet approach began to show themselves. The coming of radar was everything. The ability to spot attackers in the footless halls of space enabled stalkers to implement the principle of mass—to hold their forces on the ground and launch them directly at the threat without dispersing their power all around the perimeter looking for bombers. British bombers had to go over to the sanctuary of night to survive—but for a long time, that entailed such a loss of target-acquisition ability and accuracy that it ruined their potency. In the end, the survivability evaporated because radar helped the German interceptors, but British gunners and escorts had little effect at night. The Americans attempted for a while to find sanctuary behind the many .50-caliber turrets they hung on their bombers. But that failed because it was too easy for the stalkers to mount even larger weapons and hold back their assault until radar told them the escorts had gone home. Then they could quickly find the attacking formation, hover just outside .50-caliber range, and pop away until they made their lethal hits. Finally, the impractical was made practical by the partially fortuitous combination of technologies in escort fighters, growing numbers, and changes in tactics—and the stalking birds were killed in such huge numbers that it was not long before Germany lay prostrate before the Allies, now in command of the air.

Unhappily, the emergent doctrine obsolesced as rapidly as did the World War II airplanes. In both Korea and Vietnam, the United States was unable to apply the full force of OCA attacks because of constraints arising from the limited-war scenario. Too, her great advantage in air superiority technology and experience eroded with seemingly blazing speed. From the Eisenhower adminis-tration forward, though, the exploitation of space in a nonlethal way tended to counteract that erosion. That, combined with the fall of the Communist empire, enabled the coalition to fully exploit the potential of its technological and doctrinal advantages against Iraq and achieve an air supremacy not often witnessed in the past.

But the wall is down. The "threat" has become so diffuse that thinking about the methods of commanding air and space is more difficult than ever. Technology seems to be changing as rapidly as ever, but the force structure is much diminished. There are no more Vietnam veterans in the cockpit; only a fraction of the force got combat experience in Desert Storm, and that too is disappearing. The doctrine has really not changed greatly. One wonders whether a full revolution in military affairs (RMA) is really afoot—whether all the technology and readiness training will be enough to yield air and space superiority in the next century. Certainly, potential adversaries have learned as much or more from the Gulf War as we have. Doubt remains whether we have solved the problems of command of the air in a guerrilla-war context. Because of Watergate, Linebacker III never came to measure whether or not the first two were exceptions to a general rule.

A 10-Book Sampler on Air and Space Superiority: Works for Air Force Professional Development*

Two for the Macroview:

Benjamin Franklin Cooling, ed., Case Studies in the Achievement of Air Superiority (Washington, D.C.: Center for Air Force History, 1994). This is an official Air Force history done by various authors. It is better than most anthologies because the chapters were done under contract, and the editors had more control over the coherence than is usually the case.

Mike Spick, The Ace Factor: Air Combat and the Role of Situational Awareness (Annapolis: US Naval Institute Press, 1988). Lest the title stimulate the wrong image, you should be aware that this work is much better than many of the aviation books in the popular market.

Eight for More Detailed Knowledge:

Lee Kennett, The First Air War: 1914-1918 (New York: Free Press, 1991). This book is by a long time professor at the University of Georgia. See especially chapter 4, "The Development of Air Combat."

Marshall L. Michel III, Clashes: Air Combat over North Vietnam, 1965-1972 (Annapolis: US Naval Institute Press, 1997). Colonel Michel was a fighter pilot, and the work is colored somewhat by that viewpoint. Many of his viewpoints are widely shared by crew members outside the fighter community as well. Still, it is the best work available in print about the air battle over Vietnam.

David R. Mets, Checking Six Is Not Enough: The Evolution and Future of Air Superiority Armament (Maxwell AFB, Ala.: Air University Press, 1992). This pamphlet is included not because of my high regard for its author but because, to my knowledge, it is the only recent, compact treatment of the air armament part of the struggle for air and space superiority.

Lon O. Nordeen, Air Warfare in the Missile Age (Washington, D.C.: Smithsonian Institution Press, 1985). Although this work was published before Desert Storm and takes a case-study approach, it is worthwhile. Nordeen was employed by McDonnell-Douglas in public relations for some time, but he has a better-than-average grasp of the technical and tactical details of the subject. The book covers more than the air superiority dimension of airpower.

Lon O. Nordeen, Fighters over Israel (New York: Orion Books, 1990). There is a substantial literature on the Israeli air force, and often it has had the most recent air combat experience with US equipment against air forces instructed and equipped by the USSR. Thus, the history of its struggle for air superiority in the Middle East is a worthy topic for study by Air Force warriors/scholars.

David N. Spires, Beyond Horizons: A Half Century of Air Force Space Leadership (Colorado Springs, Colo.: Air Force Space Command, 1997). Although the Gulf War was widely advertised as the first space war, there as yet has been no combat there—and possibly there will never be any. The implication for us is that the literature is highly speculative, although it is becoming vast. The Spires book is a good start, even though it has many more subjects than just space superiority.

Kenneth P. Werrell, Archie, Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defense (Maxwell AFB, Ala.: Air University Press, 1988). Carl Builder's assertion that Air Force officers are more interested in their airplanes than they are in air war receives some support in the way that the United States has dealt with ground-based air

*The sampler is intended only to provide a baseline for the generalist professional officer. It is not for specialists in military or airpower history, nor for specialists in air combat (though some of the latter might find some instruction in the historical dimension of their own specialty). A bibliography covering the whole field would be many pages long and would quickly become outdated in any event.

de fenses. Surely, they are as much a part of the air su pe ri or ity equa tion as are fight ers, but the lit- era ture on air com bat far out weighs that on sur face de fenses. Back in World War II, the ground de- fenses were a part of the Luftwaffe, but there never has been much thought [104]here about making them a part of the air arm. Werrell's book is therefore an essential part of our study.

Derek Wood, with Derek Dempster, The Nar row Mar gin: The Bat tle of Brit ain, 1940 (Washing- ton, D.C.: Smith sonian In sti tu tion Press, 1961, 1990). There is a huge lit era ture on this clash, and the bat tle in deed was a semi nal event in the evo lu tion of air power the ory and doc trine. It remains the clos est ap proach to a pure air bat tle, and the Luft waffe was op er at ing un der many of the same handicaps that the Air Force had over North Vietnam. This book was written by two British jour- nal ists with good writ ing skills and a grasp of tech ni cal and tac ti cal de tails. The bat tle proved that the bomber would not always get through.

One for Good Measure:

Air Force Doc trine Docu ment (AFDD) 1, Air Force Ba sic Doc trine, Sep tem ber 1997. You will have to read this sooner or later; why not now? At the very least, it will fa mil iar ize you with the standard con cep tual frame work and vo cab u lary, and those things will cer tainly fa cili tate your fur ther study on air and space superiority.

One of the pillars of our self-assurance in the struggle for air and space superiority has long been the notion, perhaps the conceit, that our people have more initiative than those elsewhere—especially those in the Communist empire. But the centralized C^2 system, the wonderful instant-communications systems, and VIP jet travel may have led to micromanagement over the last half cen tury that has eroded the de gree to which junior people have de vel oped that ini- tia tive. The Air Force Acad emy has just gradu- ated its 40th class. The stu dent body there has been drawn down much less than has the of fi- cer corps in gen eral. Their re ten tion, as dis ap- point ing as it has been, has nev er the less been higher than that of other sources of officers. Diversity on the faculty and among the Air Officers Commanding is much diminished. The last two chiefs of staff and the greater part of the current three- and four-star generals are Academy graduates. We live in an age of "political correctness" wherein a single mis- take is of ten thought to be the death knell of a career. If indeed we do bank on individual initiative among our war fighters and their leaders, are we counting on a chimera? Is Mar shall Mi chel cor rect in his low es ti mate of the open-mindedness of the sen ior of fi cers of the service?

Another of the great advantages upon which we found our confidence is "information warfare" (IW) superiority. But that, combined with our doctrine, does much to drive centralization even further—and to make us all the more dependent upon cen- tralized technological systems with obvious nodal points. Just as the last great wave of im- perialism was brought to an end when the co lo ni als learned how to use the Maxim gun, is it in evi ta ble that this lead in IW will dis ap- pear? As we have noted, GPS has become in- creasingly central to our operation in many ways, and tech ni cians as sure us that it is ECM re sis tant—but that is what they said about the German Enigma machine. It was a code that could not be broken—but it was.[105] Similarly, we now possess an enormous lead in space, and perhaps the law of diminishing returns will set in. Meanwhile, the rest of the world may still be on the steep part of their de vel op- ment curves, and the gap there will also close. Will it close all the more rap idly if those of us who would end the "free dom of space" pol icy have our way? If they succeed in weaponizing space, will that only so threaten the rest of the world as to stimulate their efforts to close the

gap even more rapidly? Would we then be able to duplicate the kind of air and space supremacy that we enjoyed in the Gulf War of 1991?

But what can professional air warriors/ schol ars do about it? How can they help to assure that somehow their country will be able to sustain air and space superiority? There is no need to deliver a sermon about being the best in one's own spe cialty. But are we in general as competent to think about war as opposed to battle, engineering, maintenance, logistics, and the like? One cannot do much to practice war, and even those things that simulate battles, campaigns, and wars are always wrong. They are also expensive and time-consuming. They have to be supplemented with an or gan ized, pro fes sional reading program. Certainly, that is an imperfect substitute for experience, but it is the only substitute one has available in a lifetime limited to, say, 76 years. You can not live it all, so you must sup ple ment your real-world ex peri ence with the vi car i ous ex pe ri ence called professional reading. Because the most important of the Air Force core competencies is air and space superiority, you should concentrate on that area above all—all the more so if you are not directly involved in that area in the course of your day-to-day work. The "10-Book Sampler" included here is intended to help you get started in that effort.

Could that sampler also be a useful aid in repairing one of the glaring deficiencies of the officer corps? I had five flying tours in four different major commands, including bomber and fighter wings in SAC and Pacific Air Forces (PACAF), and never once saw anything faintly resembling an organized mentorship effort. Why not use the books in the sampler to start a mentorship program in your unit?

Finally, if you were king for a day, would you ever re place a con ge nial dummy as your chief of staff with a nasty gen ius? Are you capable of resisting the temptation to kill the bearer of bad tidings? Will you ever be able to do anything to erode the impression in the officer corps that it is a One-Mistake Air Force? □

Notes

1. AFDD 1, September 1997, 29, describes it as air and space superiority and places it at the head of the list of Air Force core competencies; it appears that the recent changing of the guard at Headquarters USAF will result in a change of the nomenclature in the next version of Basic Doctrine, in that we shall revert to the old term aerospace.

2. The best short treatment of the subject is Lee Kennett, The First Air War: 1914-1918 (New York: Free Press, 1991), chap. 4, pages 63-82.

3. Harper Lee, To Kill a Mockingbird (Philadelphia: Lippincott, 1960).

4. Marshall L. Michel III, Clashes: Air Combat over North Vietnam, 1965-1972 (Annapolis: Naval Institute Press, 1997).

5. The relevant parts are in AFDD 1, pages 29 and 47-48.

6. Maj J. C. Carter, "The Cult of the Offensive" (master's thesis, School of Advanced Airpower Studies [SAAS], Maxwell AFB, Ala., 1997). Carter's work won the Air Force Historical Founda- tion's award for the best SAAS thesis for academic year 1996-1997.

7. Col Maris McCrabb, "The Evolution of NATO Air Doctrine," in The Paths of Heaven: The Evolution of Airpower Theory, ed. Col Phillip S. Meilinger (Maxwell AFB, Ala.: Air University Press, 1997), 455.

8. Giulio Douhet, The Command of the Air, trans. Dino Ferrari (1942; new imprint, Washington, D.C.: Office of Air Force History, 1983), 23.

9. Maj Gen Haywood S. Hansell Jr., The Air Plan That Defeated Hitler (Atlanta: Higgins-McArthur/Longino & Porter, 1972), 40.

10. AFDD 1, page 29.

11. Ibid., 29, 45-47.

12. Ibid., 46.

13. Samuel P. Huntington, The Soldier and the State: The Theory and Politics of Civil-Military Relations (Cambridge, Mass.: Harvard University Press, 1957), 234-42.

14. Douhet, 18-19.

15. Maj William Mitchell, Aviation Section, Signal Corps, memorandum to chief of staff, American Expeditionary Force, 12 June 1917, in The U.S. Air Service in World War I, vol. 2, Early Concepts of Military Aviation, ed. Maurer Maurer (Washington, D.C.: Office of Air Force History, 1978), 108.

16. Kennett, 63-70. Incidentally, attacking balloons was not the Little League by any means, because they so often were surrounded by heavy concentrations of AAA and small arms, making them traps for unwary aviators; shooting one down was deemed just as prestigious as defeating a Fokker.

17. Ibid.; and Mike Spick, The Ace Factor: Air Combat and the Role of Situational Awareness (Annapolis: Naval Institute Press, 1988), 32-33.

18. Kennett, 71-82; and Spick, 6.

19. William Mitchell, lecture to Army War College, 24 November 1922, file no. 240-49, US Army Military Institute archives, Carlisle Barracks, Pa. Mitchell said, "Some improvement has been made in anti-aircraft artillery. However, as I said before, we care little for anti-aircraft artillery." Douhet said it thusly: "The airplane has complete freedom of action and direction; it can fly to and from any point of the compass in the shortest time—in a straight line—by any route deemed expedient. Nothing man can do on the surface of the earth can interfere with a plane in flight, moving freely in the third dimension. All the influences which have conditioned and characterized warfare from the beginning are powerless to affect aerial action" (page 9).

20. William Mitchell, "Tactical Application of Military Aeronautics," lecture to Army War College, 1921, file no. 97-10,

page 1, US Military History Institute curricular archives, Carlisle Barracks, Pa.

21. Douhet, 18-19; and Alfred F. Hurley, Billy Mitchell: Crusader for Air Power (Bloomington, Ind.: Indiana University Press, 1964, 1975), 63.

22. This did not include, though, any public advocacy of population attack or an extreme concentration on battle planes (strategic bombers) à la Douhet.

23. Robert T. Finney's History of the Air Corps Tactical School, 1920-1940, USAF Historical Study 100 (Maxwell AFB, Ala.: Air University, 1955), is the current authority on the subject.

24. Martha Byrd's Chennault: Giving Wings to the Tiger (Tuscaloosa, Ala.: University of Alabama Press, 1987) is the least partisan work on Chennault and his "struggles" at Maxwell Field.

25. Daniel R. Mortensen, ed., Airpower and Ground Armies: Essays on the Evolution of Anglo-American Air Doctrine, 1940-1943 (Maxwell AFB, Ala.: Air University Press, 1998), 62.

26. See Hansell, 12-14, for a view from one on the bomber side of the debate.

27. Byrd, 61-64.

28. John W. R. Taylor, ed., Combat Aircraft of the World, 1909 to the Present (New York: Paragon Press, 1969), 527.

29. Ibid., 453. "Peashooters" actually got into combat as a part of the Philippine air force the day World War II started.

30. Ibid., 182.

31. Ibid., 478.

32. Ibid., 597-99.

33. Maurer, 325-44.

34. Hansell, 40-41. Hansell, incidentally, was as qualified to judge as Chennault, in that he too was an experienced fighter pilot and a graduate of Georgia Tech. Further, he had considerable engineering experience in civilian life.

35. Bernard Brodie and Fawn M. Brodie, From Crossbow to H-Bomb (Bloomington, Ind.: Indiana University Press, 1962, 1973), 207-8. The Navy was working on radar in Washington from 1935 and demonstrated it aboard ship before the war; the Army tested radar for AAA guns and for aircraft warning by 1939 as well, but little thought had so far been given to the implications for air defense and for long-range bombing.

36. Derek Wood, with Derek Dempster, The Narrow Margin: The Battle of Britain and the Rise of Airpower, 1930-1940 (1961; new imprint, Washington, D.C.: Smithsonian Institution Press, 1990), 29.

37. R. J. Overy, The Air War, 1939-1945 (New York: Stein & Day, 1980), 28-29; and Williamson Murray, "The Luftwaffe against Poland and the West," in Case Studies in the Achievement of Air Superiority, ed. Benjamin Cooling (Washington, D.C.: Center for Air Force History, 1994), 76-78.

38. Col Carl A. Spaatz to Maj Gen Henry H. Arnold, letter, 27 August 1940, box 7, Spaatz Papers, Manuscripts Division, Library of Congress, Washington, D.C.

39. Reichsmarshall Hermann Göring, interviewed by Gen Carl A. Spaatz et al., Augsburg, Germany, 10 May 1945, copy in Spaatz Collection, US Air Force Historical Research Agency (AFHRA), Maxwell AFB, Ala.

40. US Strategic Bombing Survey, Military Analysis Division, The Defeat of the German Air Force, 1945, 1947, 1, copy in Air University Library, Maxwell AFB, Ala.

41. James A. Winnefeld and Dana J. Johnson, Joint Air Operations: Pursuit of Unity in Command and Control, 1942-1991 (Annapolis: Naval Institute Press, 1993), 33-35; Alvin D. Coox, "Air War against Japan," in Case Studies, 383-442; and US Strategic Bombing Survey, Military Analysis Division, Japanese Airpower, July 1946, 103, copy in Air University Library, Maxwell AFB, Ala.

42. The United States Strategic Bombing Surveys (European War) (Pacific War) (30 September 1945, 1 July 1946; reprint, Maxwell AFB, Ala.: Air University Press, October 1987), 37-38.

43. John Lewis Gaddis, We Now Know: Rethinking Cold War History (New York: Oxford, 1997), 1-25.

44. Eduard Mark, Aerial Interdiction in Three Wars (Washington, D.C.: Center for Air Force History, 1994), 287-319. Mark argues that the conventional view that we had air superiority because our kill ratio of enemy fighters was something above 10 to one obscures the fact that we did not command the skies. The Communist MiGs so threatened the B-29s in daylight near the Yalu River that they could not operate there for half the day. The great advantage in numbers enabled them to so stalk our interdictors up north, even while losing great numbers in the air battle meant that we did not have air superiority. But it is probably fair to say that his is a rare opinion depending heavily on his own definition of what air superiority is.

45. During the latter part of the war, the UN was able to emplace a radar on one of the islands off the west coast of North Korea, and that diminished the Communist advantage somewhat.

46. Thomas C. Hone, "Korea," in Case Studies, 453-98. Hone is much more certain than Mark that air superiority was achieved and maintained by UN forces in Korea.

47. The joint operations center had its main impact in the air-to-ground battle, mostly CAS. Winnefeld and Johnson, 49-50.

48. Maj Lee T. Wight, interviewed by author, 7 April 1998, Maxwell AFB, Ala.

49. Robert Frank Futrell, The United States Air Force in Korea, 1950-1953, rev. ed. (Washington, D.C.: Office of Air Force History, 1983), 697.

50. Bill Gunston, The Illustrated Encyclopedia of Aircraft Armament (New York: Orion Books, 1988), 55; and Frederick I. Ordway and Ronald C. Wakeford, International Missile and Spacecraft Guide (New York: McGraw-Hill, 1960), 34-35.

51. David N. Spires, Beyond Horizons: A Half Century of Air Force Space Leadership (Peterson AFB, Colo.: Air Force Space Command, 1997), 271; and Jeffrey T. Richelson, A Century of Spies: Intelligence in the Twentieth Century (New York: Oxford, 1995), 170-72, 295.

52. Spires, 50-51.

53. Lt Col Thomas Tobin et al., Last Flight from Saigon (Washington, D.C.: Office of Air Force History, 1985), 103.

54. David R. Mets, Land-Based Air Power in Third World Crises (Maxwell AFB, Ala.: Air University Press, 1986), 109-10; and Richelson, 333-34. The Soviets were better informed of the Israeli truce violations than were the Americans because their short-life satellites had to be launched and recovered more frequently than the "better" US satellites; consequently, their information was more recent than ours.

55. Actually, the Air Force did activate its first aggressor squadron between Linebacker I and II.

56. For background on some of the things that were done in fighter training before Vietnam, see Blake Morrison, "Gunsmoke: A History, a Tradition, a Competition," USAF Fighter Weapons Review, Fall 1981, 3-12.

57. Over time, the time-of-flight problem was mitigated by tactical development, but the requirement for visual identification remained a serious handicap. Maj Matthew Donovan, interviewed by author, 23 March 1998, Maxwell AFB, Ala. Donovan was a Fighter Weapons School instructor and also an aggressor squadron pilot.

58. Semiactive radar missiles have a radar receiver and a control system that guide them toward the source of the radar energy. That means that the aircraft radar has to continue bouncing the radar signal off the enemy aircraft until the time of impact. Some of the newer missiles, such as the AIM-120, have active radars—that is, they can be launched at a target, and they have their own radar transmitters as well as receivers. At some point in their trajectories, their own radar transmitters will start "painting" the target; thus, they will home on the energy reflected back from their own radar signals. That means that the launching aircraft can leave as soon as the missile is on its way (in one mode of its operation, at least).

59. It was smaller than the radar missile, though. The AIM-9L, which is the current version, weighs less than half as much.

60. Capt Allan Miller, "Top Gun Program," USAF Fighter Weapons Review, Winter 1986, 8-12.

61. Lt Gen John J. Burns, USAF, Retired, interviewed by Hugh Ahmann, Saint Louis, Mo., 5-8 June 1984, file no. K239.0512-1587, AFHRA, Maxwell AFB, Ala.

62. Ibid.

63. As it happens, once the realistic training was introduced after the Vietnam War, the accident rate actually went down—not up. Maj Scott Walker, USAF, interviewed by author, 25 March 1998, Maxwell AFB, Ala.

64. Lon O. Nordeen, Air Warfare in the Missile Age (Washington, D.C.: Smithsonian Institution Press, 1985), 111-23; and Brereton Greenhous, "The Israeli Experience," in Case Studies, 578-82.

65. Michael Howard, "Military Science in an Age of Peace," Chesney Memorial Gold Medal lecture, 3 October 1973, reprinted in Journal of the Royal United Services Institute 119 (March 1974): 3-11.

66. Greenhous, 586-96; and Nadav Safran, "Trial by Ordeal: The Yom Kippur War, October, 1973," International Security 2 (Fall 1977): 130-62.

67. Nordeen, 158-72; and Safran, 130-62.

68. Nordeen, 201-6; Matthew M. Hurley, "The Bekaa Valley Air Battle, June 1982: Lessons Mislearned," Airpower Journal 3, no. 4 (Winter 1989): 60-70; and Nick Kerr, "The Falklands Campaign," Naval War College Review 35 (November-December 1982): 14-21.

69. Maj Gerald R. Volloy, "Red Flag in Perspective," USAF Fighter Weapons Review, Spring 1979, 2-5; and "Training and Simulation: Filling the Missing Link," Jane's Defence Weekly, 13 April 1991, 606-9.

70. Wight interview.

71. The F-5 had an advantage throughout, however, because of its greater maneuverability. Donovan interview.

72. Walker interview.

73. Air Force Manual (AFM) 1-1, Basic Aerospace Doctrine of the United States Air Force, vol. 1, March 1992, 18; and AFDD 1, 12-3.

74. Winnefeld and Johnson, 100-101.

75. That fact seems to support the Air Corps Tactical School bomber advocates in their arguments against Chennault. Without radar, they were right, and their prediction then that radar was a serious prospect would have been a superhuman act of foresight. (Doubtless, it will occur to the reader that the Luftwaffe was a much tougher opponent in a total war than the Iraqi air force was in the Gulf War.)

76. Col John A. Warden III, "The Enemy as a System," Airpower Journal 9, no. 1 (Spring 1995): 40-55; and idem, "Air Theory for the Twenty-first Century," in Challenge and Response: Anticipating US Military Security Concerns, ed. Karl P. Magyar (Maxwell AFB, Ala.: Air University Press, August 1994), 311-32.

77. Thomas A. Keaney and Eliot A. Cohen, Revolution in Warfare? Air Power in the Persian Gulf (Annapolis: Naval Institute Press, 1995), 15. This book is one of the best sources on the Gulf War.

78. Ibid., 48-49; and Michael R. Gordon and Gen Bernard E. Trainor, The Generals' War: The Inside Story of the Conflict in the Gulf (Boston: Little, Brown, 1995), 205-26, 473-74.

79. Keaney and Cohen, 159-60.

80. Winnefeld and Johnson, 146-47.

81. Col John D. Waghelstein, "Some Thoughts on Operation Desert Storm and Future Wars," Military Review 71 (February 1992): 80-83.

82. CEP is the radius of a circle within which 50 percent of the bombs, missiles, or projectiles may be expected to fall.

83. Bill Sweetman, "Scratching the Surface: Next Century Air-to-Ground Weapons," Jane's International Defence Review 30 (July 1997): 55-63. In "Experts Count Costs to Fix JDAM Design Flaws," Jane's Defence Weekly 28 (5 November 1997): 6, Stacey Evers reports that the unit cost would be about $18,000 and that the program, then in low-rate initial production, would be delayed in going to full-rate production until some design flaws revealed in testing were overcome.

84. Millimeter wave radars, ladars (laser radars), and synthetic aperture radars are all under consideration. Without them and a sophisticated set of algorithms, only versions of JSOW and JDAMS carrying dispenser warheads with appropriate submunitions will have any chance against moving targets.

85. Bill Sweetman, "The Progress of the F-22 Fighter Program," Jane's International Defence Review, Quarterly Report, no. 1 (1997): 1-20. Another development is the effort to develop the small smart bomb (SSB) at 250 pounds with such accuracy that it will have the same effect as the two-thousand-pound LGB, yet six of them will fit in the F-22 weapons bay.

86. Sweetman, "Scratching the Surface," 57; "USAF Plans Inertial Dispenser Selection This Month," Jane's International Defence Review 30 (January 1997):10; and US Air Force, Headquarters Air Combat Command/DRPW, "Final Operational Requirements Document, Wind Corrected Munitions Dispenser," 23 September 1994.

87. In November 1997, it was reported that the first JSOWs were deployed aboard the aircraft carrier USS Nimitz in the Persian Gulf even though they had not achieved their IOC and were still in low-rate initial production (LRIP). The versions deployed were said to be the ones containing CEMs particularly useful against air defense sites. "Nimitz Is Carrying Latest Stand-off Weapon," Jane's Defence Weekly 28 (19 November 1997): 4.

88. Sweetman, "Scratching the Surface," 55-63; Roy Braybrook, "Not-Too-Close Encounters of the Air-to-Ground Kind," Armada International 20 (February/March 1996): 28-39; and James W. Canan, "Smart and Smarter," Sea Power 38 (April 1995): 93-96. In "Mining Silver Bullets: Navy and Air Force Pursue Longer Range, Autonomous Standoff Weapons," Armed Forces Journal International, July 1997, 26-27, Glenn W. Goodman Jr. cites an accuracy of 33 feet for JDAMS and JSOW, stating that LRIP has been approved for both the JSOW and the Navy's standoff land attack missile, expanded response.

89. David A. Fulghum, "TSSAM Follow-on to Take Shape This Year," Aviation Week & Space Technology, 27 February 1997, 49; and Headquarters US Air Force/XORW, "Joint Air-to-Surface Standoff Missile, Program Management Directive," PMD 2389 (1), 2 February 1996.

90. Stacey Evers, "JASSM Struggles on Low Budget Pending Study," Jane's Defence Weekly 28 (8 October 1997): 11. Evers reports that the unit cost range is stipulated to be between $400,000 and $700,000 per round.

91. Keaney and Cohen, 195-96. Keaney and Cohen report that soon the HARM shooters were coming back to base without having fired their weapons, and only five coalition aircraft were lost to radar SAMs during the war.

92. "Eglin's AMRAAMs Join War," Northwest Florida Daily News, 22 February 1991, 3; and Jeffrey Lenorovitz, "Allied Air Supremacy Keeps Air-to-Air Engagements Limited," Aviation Week & Space Technology, 18 February 1991, 45-46. For information about the first kill of the new missile, see news release, Hughes Aircraft Company, Canoga Park, Calif., "Hughes AMRAAM Intercepts MiG-25 in Iraq 'No-Fly' Zone," January 1992; and Bill Sweetman, "Russia Sets the Pace in the Race for Air-to-Air Missiles," Jane's International Defence Review 30 (November 1997): 70-79.

93. An air defense fighter (ADF) version of the F-16 was fielded to use AIM-7s, but the system was put together as an interim solution until AMRAAM came on the line and was not very satisfactory. Donovan interview.

94. Sweetman, "Russia Sets the Pace," 70-79; idem, "Progress of the F-22 Program," 9; and Jean Dupont, "Europe Competing Strongly in AAMs," Interavia 53 (January 1998): 42-44. Dupont

identifies the Russian R-73 and R-77 as the threats to beat but calls the AMRAAM "the reference" missile.

95. Wight interview.

96. A similar combination is being designed to retrofit our fleet of F-16s and F-15s. Walker interview.

97. Dupont, 42-43.

98. Sweetman, "Progress of the F-22 Program," 14.

99. Dupont, 42-44.

100. Donovan interview.

101. Mark Hewish and Joris Janssen Lok, "Passive Target Detection for Air Combat Gathers Pace," Jane's International Defence Review 31 (February 1998): 32-37.

102. Walker interview.

103. "Personnel Facts," Airman 42 (January 1998): 29; and Donovan interview.

104. At the time of the debate on the Unification Act of 1947, there was an effort on the part of the USAAF staff to carry the Air Defense Artillery with the airmen into the new Air Force. It never came to fruition, though, because of the airmen's desire to avoid antagonizing Gen Dwight Eisenhower and Gen George Marshall, whose support they needed. Additionally, there was not much enthusiasm for the idea among the officers in the Air Defense Artillery because they feared that the Air Force would be owned by the pilots.

105. Furthermore, civil society here and abroad is becoming so dependent upon GPS that it might prove politically and economically difficult to shut it down in time of conflict.

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